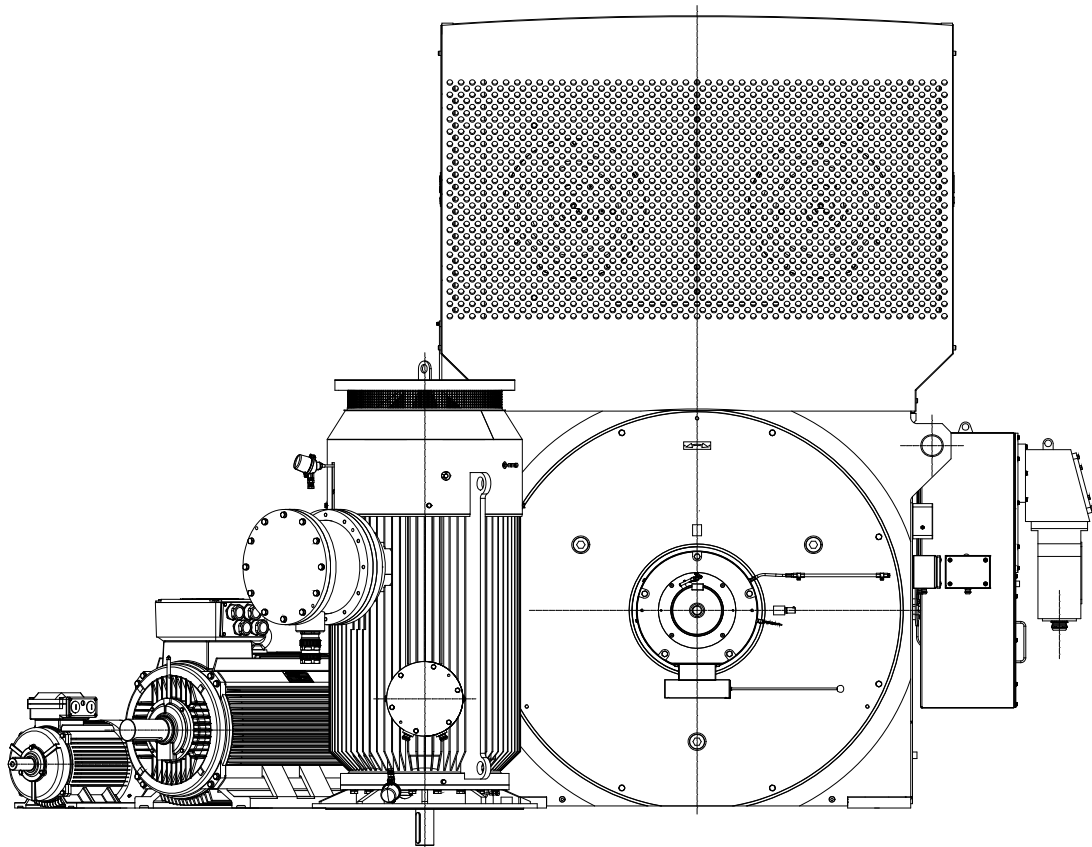


Operating Manual

High Voltage-Asynchronous Motor with Squirrel-Cage Rotor

Type : NDKK450-02-G



www.helmke.de

Customer.....: DELTA GmbH

Order-No.....: 11042200559

Ident.-No.....: 11000101138

Operating Instructions

Three-Phase Induction Motor

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Notes

These operating instructions do not contain all detailed information for clarity reasons and also cannot consider every conceivable application.

If you would like additional information or if special problems should occur, which are not treated in detail in the operating instructions, you may request the required information via the local HELMKE branch or the HELMKE service.

We would also like to point out that the content of these operating instructions are not a part of a former or existing agreement, commitment or a legal relationship or should revise one. All obligations by HELMKE result from the respective purchasing contract, which also contains the complete and solely valid warranty provisions. These contractual warranty provisions are not expanded or limited by the details of these operating instructions, however, apply only on the condition that our storage, installation, commissioning and operating instructions as well as the inspection and maintenance rules are respected and taken into account. The required measurements and controls of the delivery item must be documented and sent to HELMKE.

J. HELMKE & Co

Ludwig-Erhard-Ring 7–9
31157 Sarstedt / Germany




Phone: +49 (0) 50 66 903 33 – 0
Fax: +49 (0) 50 66 903 33 – 291

e-mail: helmke@helmke.de
Web: www.helmke.de

1 Safety Guidelines

This chapter

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol; notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

| | |
|---|---|
|  Danger | <p style="text-align: center;">Danger</p> <p>indicates that death or severe personal injury will result if proper precautions are not taken.</p> |
|  Warning | <p style="text-align: center;">Warning</p> <p>indicates that death or severe personal injury may result if proper precautions are not taken.</p> |
|  Caution | <p style="text-align: center;">Caution</p> <p>with a safety alert symbol indicates that minor personal injury can result if proper precautions are not taken.</p> |
| Caution | <p style="text-align: center;">Caution</p> <p>without a safety alert symbol indicates that property damage can result if proper precautions are not taken.</p> |
| Notice | <p style="text-align: center;">Notice</p> <p>Notice indicates that an unintended result or situation can occur if the corresponding information is not taken into account.</p> |


If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified personnel

The device / system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device / system may only be performed by qualified personnel. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed usage

Note the following:

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|  Warning | <p>This device may only be used for the applications described in the catalogue or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Helmke. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.</p> |
|---|--|


Disclaimer of liability


We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

1.1 Safety and application instructions

Safe use of electric motors

Electrical systems in locations subject to explosion hazards must be assembled, installed, and operated in accordance with the applicable rules and regulations. It is assumed that system operators can ensure that the above-mentioned rules and regulations are observed during assembly, installation, and operation, and that the appropriate tests are carried out. We recommend that these tests be carried out and documented in coordination with the authorities responsible.

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|  Danger | <p>Electric motors are designed for use in industrial power systems. Rotating or live and uninsulated parts can be dangerous.</p> <p>Fatal or severe injuries and substantial material damage can occur if the required covers are removed without authorization or if the equipment is not handled, operated, or maintained properly.</p> |
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|  Danger | <p>If the motors are used outside industrial areas, the installation site must be safeguarded against unauthorized access by means of suitable protection facilities (e. g. fencing) and appropriate warning signs.</p> <p>Binding clarification of the on-site risks and of any required measures can only be provided by the system operator in agreement with the supervisory authority responsible.</p> |
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The persons responsible for the safety of the system are obliged to ensure that:

- ▶ basic system planning as well as all transportation, assembly, installation, commissioning, maintenance, and repair activities are carried out and checked by qualified personnel,

- ▶ these instructions and the motor documentation are available at all times while work is in progress,
- ▶ the technical data and specifications regarding the permissible installation, connection, ambient, and operating conditions are taken into account at all times,
- ▶ the system-specific construction and safety regulations are observed and personnel protective gear is used,
- ▶ all work on these motors or in the vicinity of these motors must be carried out by qualified personnel only.

For this reason, these operating instructions only contain the information required for the motors to be used by qualified personnel in accordance with their intended purpose.

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| Note | We recommend engaging the support and services of your local HELMKE service centre for all planning, installation, commissioning, and maintenance work. |
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1.2 Switching high-voltage motors

Switching surges

When vacuum circuit-breakers and vacuum contactors are used, it is possible for so-called multiple reignitions to occur on disconnection, depending on various factors (such as the circuit-breaker turn-off principle, motor size, length of the incoming cable, system capacitance etc.).

As a result of these reignitions, in individual cases there may be inadmissibly high switching surges for the insulation of the motor stator winding, namely when high-voltage motors with starting currents $I_S \leq 600$ A are switched off during starting or after blocking. Depending on the ratio of starting current to nominal current, and depending on the mains voltage dip (up to approx. 20 %) during motor start-up, this current limit corresponds to an upper power output limit of approx. 750 kW at $U_n = 3$ kV, approx. 1500 kW at $U_n = 6$ kV and approx. 2500 kW at $U_n = 10$ kV.

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| Caution | For high-voltage motors up to this size, the planning departments must make provision for appropriate overvoltage limiters, when vacuum circuit-breakers and vacuum contactors are used. |
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A limiter to ground is installed in the switchgear between the circuit-breaker and the cable termination for each of the three conductors. The level of protection for the motor windings is sufficient given the correct choice of limiters (rated motor voltage / response voltage).

1.3 Electromagnetic compatibility

Instructions relevant to safety

When used in accordance with their intended purpose and operated in an electrical supply system with characteristics to EN 50160, the enclosed motors (IP54 and higher) comply with the requirements of the EU Directive 2014/30/EU concerning electromagnetic compatibility.

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| Notice | If the load torque is very irregular (e. g. when driving a reciprocating compressor) a non-sinusoidal motor current will be induced whose harmonics might bring about an excessive reaction on the supply system and so cause excessive emitted interference on the power supply connecting leads. |
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| Notice | If operated in combination with converters, the emitted interference is varying in strength, depending on the design of converter (type, interference suppression measures, and manufacturer). In order to avoid exceeding the limit values as per IEC/EN 61000 on the drive system, consisting of motor and converter, the EMC information given by the converter manufacturer must strictly be observed. On motors with integrated sensors (e. g. PTC thermistors), interference voltages caused by the converter may occur on the sensor lead. |
|---------------|---|

The motor generally fulfils the requirements of interference immunity in conformity with IEC/EN 61000. If using motors with integrated sensors, the operator himself must ensure sufficient interference immunity by selecting a suitable sensor signal lead and a suitable evaluation unit.

2

Description

2 Description

2.1 Intended use

These low-voltage machines are intended for industrial installations. They comply with the harmonized series of standards IEC/EN 60034. Their use in hazardous areas is prohibited unless they are expressly intended for such use. (observe additional instructions). The degrees of protection \leq IP23 are by no means intended for outdoor use. Air-cooled models are rated for ambient temperatures of $-20\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ and altitudes of \leq 1000 m above mean sea level (MSL).

Ambient temperature for air-/water-cooled models should be not less than $+5\text{ }^{\circ}\text{C}$ (for sleeve-bearing machines, see manufacturer's documentation). By all means, take note of deviating information on rating plate. Field conditions must conform to all rating plate particulars.

Low-voltage machines are components for installation in machinery as defined in the Machinery Directive 2006/42/EC. Commissioning is prohibited until conformity of the end product with this directive has been established (observe e. g. IEC/EN 60204).

The details of the version of the delivered machine as well as the approved operating conditions may be derived from the machine documentation.

Table 2-1 Compliance with standards

| Feature | Standard |
|--------------------------------------|-----------------|
| Dimensions and operating performance | IEC/EN 60034-1 |
| Degree of protection | IEC/EN 60034-5 |
| Cooling | IEC/EN 60034-6 |
| Construction type | IEC/EN 60034-7 |
| Noise emission | IEC/EN 60034-9 |
| Vibration severity levels | IEC/EN 60034-14 |

The data regarding the actual degree of protection, cooling, and the construction type should be taken from the motor documentation in the annex.

3 **Transport, Storage, Installation and Assembling**

3 Transport, Storage, Installation and Assembling

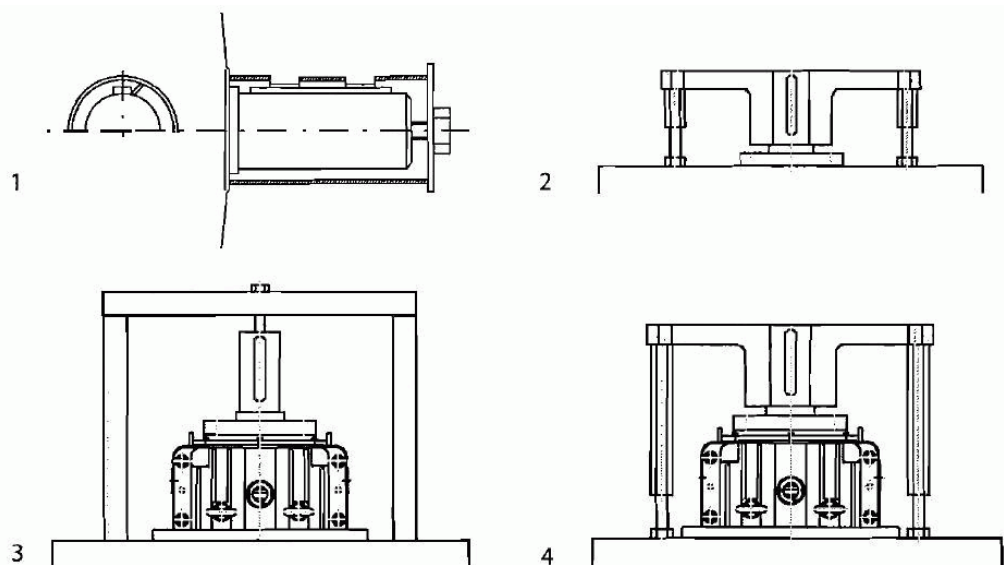
3.1 Transport


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| Caution | The protection class according to the technical specifications no longer applies if the motor and the radiator are transported or stored separately. IP00 applies. Special, professional measures must be taken to ensure protection against contamination and humidity. This applies particularly to transport and for storage outside. |
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Transport

Immediately report damage established after delivery to transport company; Stop commissioning if necessary.

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| Caution | The enclosed rotor blocking equipment must be solidly attached during the transport, in order to prevent transport damages. This equipment must only be removed prior to attaching the power takeoff (PTO) element. If the machine has to be transported after mounting the PTO element, other suitable measures must be applied for the axial stabilization (see figure below). |
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|  Warning | <p>Motors may only be transported and hoisted in a position corresponding to their construction type. The motors may only be hoisted using the hoisting lugs provided on the stator housing; use suitable cable guiding or spreading devices / equipment. (Motor weight refers to the rating plate or technical specifications).</p> <p>The handling instructions and markings on the motors must be observed whenever they are transported. The motor's centre of gravity is also indicated in the dimension diagram of the motor. If the centre of gravity of a load is not located centrally between the attachment points, the hoisting hook must be positioned above the centre of gravity. Pay attention to the different loads on the sling ropes or hoisting straps.</p> |
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|  Warning | <p>Only the intended openings, eyebolts and lifting pins on the base-plates may be used for transporting motor sets. Always pay attention to the carrying capacity of the lifting device. Motor sets must not be lifted by attachment to the individual motors.</p> |
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3.2 Storage

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| Notice | <p>The machines should be stored inside a closed room. If they are stored outside, it is more difficult to maintain the necessary conditions and the risk of corrosion and bearing damages increases.</p> <p>The machines and their accessories should be kept in their original packaging for transportation.</p> |
|---------------|--|

Storage location

The storage area shall be dry, dust-, frost- and vibration-free and well ventilated. The ambient air must be free of aggressive gases and salt spray (sea air). The machines must be protected against insects and vermin such as termites and rodents as well as against the access of unauthorized persons.

Keep the relative humidity below 50 %. The ambient temperature shall be between 5 °C and 60 °C and must not be below the minimum rated temperature in general.

At higher humidity, the machine temperature should be kept approximately 10 K above the ambient temperature to avoid condensation. The temperature variation shall be less than 10 K per day. If it exceeds 10 K, turn on the anti-condensation heater, energize the machine windings or arrange other measures to increase the machine temperature relative to the ambient temperature. For that purpose a constant power supply providing the required power must be available.

If these conditions cannot be met, cover the machines with polythene foils and seal the seams for hermetical sealing. A desiccant must be used for the absorption of the water vapor inside. Humidity indicators have to monitor the air humidity inside the cover in multiple steps. Supervise the desiccant periodically and renew if necessary.

The covering has to be applied with utmost care. Ask an experienced packaging company if necessary.

Machines with sleeve bearings are generally delivered without oil. They should be stored in this condition. Machines with oil filled sleeve bearings cannot be stored for a period longer than two months unless an auxiliary device assists in turning with a speed greater than 30 rpm. Otherwise drain the oil and preserve the appropriate areas of the bearings.

Spare parts must be stored in the same manner.

Storing outdoors

Choose a storage location that is large enough, close to transportation routes and not susceptible to or protected against flooding. Repair any damage to the packaging before putting the equipment in storage. This is necessary to ensure proper storage conditions. Position machines, devices and crates flat on pallets, wooden beams or foundations that guarantee protection against soil moisture. Prevent the equipment from sinking into the ground and ensure the circulation of air underneath the equipment.

Covers or tarpaulins used to protect the equipment against rain, snow and heavy sun must not make contact with the surfaces of the stored equipment. Ensure adequate air circulation by positioning wooden spacer blocks between the equipment and such covers.

Create air ventilation and water draining holes in wooden boxes.

3.2.1 Preparation of storage and preservation (mothballing)

It is strongly recommended to log all ambient conditions and activities during preparation and storage. This especially includes all disassembling and conservation work in order for it to be checked regularly and to allow for the restoration of original conditions at the end of storage. Log all activities at the beginning and the end of as well as during the storage in order to identify faults in case of actual or later damages.

Activities at the beginning of storage:

- ▶ Check the coating and refinish if necessary.
- ▶ Protect uncoated surfaces with removable anti-corrosion coating (e. g. TEXTYL 506 or 511).
- ▶ Sleeve bearings: open the upper covers. Preserve shaft, bearing shells and all bare surfaces with removable anti-corrosion coating or with a corrosion protection which dissolves itself in the lubricating oil filled for operation. Seal all terminals and gaps.
- ▶ Mount the rotor blocking equipment. If the original rotor locking device with which the machine was supplied is no longer available or can no longer be used due to the installation of transmission elements (couplings, pulleys, etc.), other measures are required to lock the rotor.

- ▶ Open the water draining openings. Attention must be paid to a possibly changed IP protection class.
- ▶ Turn on the anti-condensation heater, energize the machine windings or arrange other measures to increase the machine temperature relative to the ambient temperature.

3.2.2 Inspection and maintenance during storage for extended periods of time (long-term storage)

Monthly

- ▶ Measure the vibrations at the storage location.
- ▶ Check the ambient humidity respectively the humidity inside the hermetically sealed cover. Change the desiccant if necessary.
- ▶ Check the ambient temperature.
- ▶ Check the anti-condensation heater input current.

Every two months

- ▶ Check cleanness if not hermetically sealed.
- ▶ Check for potential insect infestations and damages by vermin.
- ▶ Check the isolation resistance.
- ▶ Anti-friction bearings: Turn the shaft by 10 revolutions. Remove rotor blocking equipment and remount after done work. Rotation can be omitted if there is time enough during commissioning to check the bearing (vibration measurement when the machine is rotating) and to replace them, if necessary.
- ▶ Oil filled sleeve bearings: Turn at a minimum speed of 30 rpm for 10 minutes. Remove rotor blocking equipment and remount after done work.

Every six months

- ▶ Check the hermetical seal.
- ▶ Check the coating.
- ▶ Check the protection on uncoated surfaces.
- ▶ Antifriction bearings: Regrease.
- ▶ Sleeve bearings without oil filling: Open the upper covers and check the corrosion protection. Remove rotor blocking equipment and remount after done work.

Every two years

- ▶ Clean the terminal box if not hermetically sealed.
- ▶ Sleeve bearings: Disassemble completely and check all parts. Renew anti-corrosion protection. Remove rotor blocking equipment and remount after done work.

Activities at the end of storage – recommissioning

The operating instructions, data sheets as well as the general safety instructions and the applicable standards must be observed in all points.

- ▶ Clean the machine.

- ▶ Clean terminal box.
- ▶ Remove anti-corrosion coating and restore disassembling.
- ▶ Anti-friction bearings: regrease. After more than two years, use twice the quantity of grease specified on the lubrication plate / in the data sheet and, if necessary, replace the bearings after storage of more than three years or after 18 months in the case of poor storage conditions. When motors are not stored vibration-free, the bearings must always be replaced.
- ▶ Isolated anti-friction bearings: Change bearings after two years of storage.
- ▶ Sleeve bearings: Remove anti-corrosion coating. Check bearing shells. Change if the bearing shells have imprints. Change or fill oil.
- ▶ Check the isolation resistance.
- ▶ Check the polarization index and / or the partial discharge.

3.3 Installation

- ▶ Make sure of even support, solid foot or flange mounting and exact alignment in case of direct coupling.
- ▶ Avoid resonances with rotational frequency and double mains frequency as a result of assembly.
- ▶ Avoid excessive radial and axial bearing loads (note documentation).
- ▶ Make necessary ventilating pipe connections. Models with shaft ends pointing upward have to be provided with cover by customer. The ventilation must not be obstructed and the exhaust air, also of neighboring sets, not taken in directly.

Cooling


The cooling air must be able to be drawn in and discharged unimpeded; ensure that warm discharged air is not drawn back in at the air intake. The minimum distance to the wall shall be 25 % of the air inlet respectively the air outlet diameter. On the vertical motor design with air intake from above, the air inlets must be protected against the ingress of foreign bodies and water.

Balancing quality

The rotors are balanced dynamically. For shaft ends with featherkeys, the balancing type is specified using the following coding on the face of the drive end of the shaft:

- ▶ Code 'H' means: balancing with half a featherkey (standard version); this means that in order to maintain the balancing quality, it may be necessary to cut back the part of the featherkey protruding from the drive element and the shaft profile if the motor has a short output element.
- ▶ Code 'F' means: balancing with a whole featherkey (this is a special version which must be ordered separately).

Please make sure that the power output element is correctly balanced. Power output elements may only be fitted or removed using suitable equipment.

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|  Warning | The featherkeys are only secured during transport to prevent them from falling out. If the motor has two shaft ends, and a power output element is only fitted to one end, steps must be taken to secure the featherkey at the other end. If the rotor has the standard type of balance 'H', the featherkey must be cut back to roughly half of its normal length. |
|---|--|

Noise emission

When assessing the noise that is emitted at a workplace (if any), it should be taken into account that the A-weighted sound pressure level, measured in accordance with ISO 1680, namely 70 dB(A), is exceeded if the three-phase AC motors are operated with the rated output.

Water drain holes

If the motor is equipped with water drain holes, then they are situated in the foot area of the bearing end shields on the drive end and non drive end side and opposite the regreasing devices. They are sealed with plastic plugs. If there is a risk of condensation forming in the motor (e. g. due to severe fluctuations in ambient temperature or direct sunlight, even with high air humidity and intermittent operation or load fluctuations), it may be useful to remove the plugs located at the bottom (depending on installation position).

Vertical machines

At vertical mounted motors with shaft end up- or downwards (e. g. IM V1, IM V2, IM V5 or IM V6) assure that neither water nor other liquids can ingress into the upper bearing. Even with degree of protection IPX5 or IPX6, there is no durable sealing against permanent occurring liquids. For this purpose, protective roofs or customized, possibly rotating covers have to be installed by the user, which belong to the conditions on site.

3.4 Aligning

Instructions relevant to safety

Detailed specialist knowledge of the necessary measures is required in order to correctly align and securely mount the equipment, e. g. for:

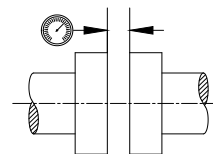
- ▶ preparing the foundation,
- ▶ selecting and mounting the coupling,
- ▶ measuring the concentricity and axial eccentricity tolerances,
- ▶ positioning.

If personnel are not familiar with the necessary measures and procedures, we recommend using the services of the local HELMKE service centre.

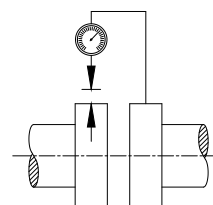
Vertical and horizontal position

The shafts in clutch operation must be aligned axially and radially against each other. Gauges must be mounted securely, whereby measurements must be performed on four points, which are offset by 90° each, by simultaneously turning both clutch halves.

The adjacent image shows the axial measurement (angular misalignment). Adjust differences with metal supports. The remaining accuracy may not be greater than 30 µm in reference to a measured diameter of 200 mm.



The adjacent image shows the radial measurement (eccentricity). Compensate differences by shifting or padding the relevant plates so that a residual inaccuracy of 30 µm is not exceeded.



The option of an electronic measurement and alignment is offered as a modern and especially precise alternative to the above listed method. Precisely processed steel clutches can also be aligned with sufficient precision with tram gauges and feeler gauges.

Belt drives require verification that the two matching disks are flush, i. e. both shafts must be located parallel to each other and the connecting line between the disk centers must form a right angle with the shafts. It is also important that the belt tension is completed according to the guidelines of the belt manufacturers. Unnecessary high initial tension designates a risk for the shafts and bearings.

Alignment accuracy

A diameter of 0.05 mm is required to satisfy the coaxial requirements for the shafts of the motor and the driven machine.

3.5 Mounting

In order to ensure smooth, vibration-free motor operation, a stable foundation design in accordance with DIN 4024 is required, the motor must be precisely aligned, and the components, which are to be mounted on the shaft end, must be correctly balanced. In addition, vibration speeds must meet the requirements of DIN ISO 10816-3. For new motors applies IEC/EN 60034-14.

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| Notice | The area of placement must be flat with a maximum deviation of 0.1 mm. High accuracy can be achieved by placing thin shims. |
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| Notice | <p>The horizontal and vertical natural frequencies of the foundation including machine must be different from</p> <ul style="list-style-type: none"> ▶ ±10 % of the rotational frequency of the machine ▶ ±5 % at twice of the rotational frequency of the machine ▶ ±5 % of the single and double mains frequency |
| Notice | <p>The maximum vibration speeds occurring in horizontal and vertical direction on the machine foundation near the motor feet shall not exceed 25 % of the maximum vibration speeds measured on the bearing housings of the machine in the same direction, Otherwise, it is assumed that the foundation is too elastic and the vibrations of the machine are increased.</p> |
| Note | <p>Where a belt drive is used, it is of advantage to use sliding rails to mount the motor so as to be able to set the correct belt tension.</p> |
| Notice | <p>The bearings and shaft can be damaged if the belt tension is too high. It is essential, therefore, that you adhere to the permissible values.</p> |

Motors that are attached by their mounting feet to the wall because of their design must be supported from below by a wall strip, for example, or pinned.

Use machine fixing bolts with the necessary strength class to ISO 898-1 (e. g. 10.9) for reliable mounting and safe transmission of forces results from torque. When selecting the bolts and the design of the foundation you must take into account the maximum forces occurring in the case of a fault (e. g. short circuit or system transfers in phase opposition). The values for the foundation forces can be found in the configuring documentation or are available on request from the manufacturer.

Clutches or other drive side elements may only be pulled, i. e. removed (heating!) with suitable tools and covered with an accidental-contact protection.

Only clutches with a perfect, i. e. even driver pitch may be used. The identical elasticity factor and quality condition must be verified for a complete set of elastic transfer elements. Any non-uniformity causes flexural vibrations in the shaft area due to cranking forces, especially at high torque, resulting in a risk of serious motor damages due to grinding the rotor in the stator core. The manufacturer's instructions regarding the assembly and alignment must be observed specifically for special clutches. Pulleys, etc. must be balanced dynamically and possibly at the operating speed.

Motors with reinforced bearings (cylindrical roller bearing on drive side) may incur problems of a different type under certain circumstances: if fast (2- / 4-pole) motors of a small to medium size are coupled via a shackle (e. g. ELCO) and very well centered, the cylindrical roller bearing on the drive side is radially barely stressed. This may then

result in running problems, which result in the rolling elements slipping on the wearing surfaces. An unexpected increase of the bearing temperature is the result.

The entire drive concept with consideration to the thermal longitudinal expansion of the shafts as well as the radial/axial loads, etc. is essential for the bearing decision.

3.6 Connecting the stator winding

Compare the grid type and desired operating data with the motor rating plate – note the connection type. If not otherwise specified, the performance data (with tolerances according to IEC/EN 60034) relate to a max. 40 °C ambient temperature at a maximum set-up height of 1,000 m above MSL, possibly under the conditions of the specified coolant or external air data.

The connection must be performed according to local installation regulations by using the proper cables. Terminals for earthing the housing may be found in the terminal box or below at the motor pedestal. The connection diagram, which may be found in the terminal box, must be observed. Special care is required for voltage or pole changing motors – we request that you contact us prior to start-up in the event of uncertainty.

The motor shaft will turn toward the right when viewed from outside against the shaft journal at an equidirectional connection of power phases L1, L2, L3 to motor connection U1, V1, W1 – therefore clockwise. If a counter-clockwise rotation is desired, two phases must be exchanged.

| | |
|---------------|---|
| Notice | The rating plate of motors, which are only suitable for one direction of rotation due to rotation direction dependent fans, contains a suitable marking. A direction of rotation arrow is also attached to the motor housing above the journal or on the fan cover. A contrariwise rotation is not permitted, since the motor is then overheated due to a lack of cooling air. A change in the direction of rotation can only be achieved with new or modified fans. In such a case the rebalancing of the rotor may also become necessary! |
|---------------|---|

All terminals must be firmly tightened, since extreme heating and therefore a destruction of the insulation may be anticipated.

The connections of any temperature monitoring systems (such as PTC thermistors, Pt100-measurement resistors) for the winding and bearings as well as an anti-condensation heater, etc. are generally located in an additional terminal box including the connection diagram and technical data. The use of this system is necessary in the interest of operating safety. In order to prevent potentially serious damages due to an incorrect connection, we are requesting that you contact us, if you need information of the necessary analysis systems, etc.

A switching device with a short-circuit release and a thermal overcurrent tripping devices adjusted to the rated winding current must be used to realize an upstream motor protection.

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| Notice | The thermal tripping devices of squirrel-cage induction motors with star-delta starting must detect the phase winding current in the delta connections between the motor and the breaker (contactor) and must therefore be set at the lower star current ($= 0.577 \cdot \text{rated motor current}$). |
|---------------|--|

Connection with cable lugs

Remove the insulation from the conductor ends so that the remaining insulation is almost long enough to reach the cable lug. If necessary, insulate the cable lugs in order to maintain the minimum air clearances. The air clearance for maximum operation voltages up to 6.3 kV +10 % must be at least 60 mm; the minimum air clearance for maximum operation voltages up to 10 kV +10 % is 100 mm.

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| Notice | The current-carrying capacity of the connection is ensured by the CuZn contact nuts. These nuts must not be replaced by parts made from other materials. |
|---------------|--|

Connection without cable lugs

Clamp-type terminals can be ordered, which are suitable for connecting flexible conductors without wire end ferrules.

Wire end ferrules should only be used if they are attached to the conductor before connection, using an appropriate, current-carrying crimp connection.

To ensure safe clamping and enclosure of the conductor end, only one conductor can be connected.

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| Notice | If aluminum conductors are connected, we recommend removing the oxide film using a brush or file prior to inserting them in the clamps. The conductors should then be immediately greased using neutral Vaseline in order to prevent re-oxidation. Yielding of the aluminum is also likely after the conductors have been connected due to the contact pressure. This should be compensated by tightening the clamping nuts after approximately 24 hours and again after about 4 weeks. |
|---------------|---|

Cable entry and routing

The connecting cable is sealed at the cable entry location and is fastened using a strain relief device. The strain relief device can be located either in the terminal box or externally.

We recommend the following procedure while using cut-out seal insert:

- ▶ Cut out the seal insert so that its opening is 1 to 3 mm smaller than the cable diameter. If the cable diameter is too small, increase it by wrapping a layer of suitable sealing tape around the conductor.
- ▶ After inserting the seal, make a termination to match the cable and connect an earthing cable to it. If the cable has external armoring, do not route it directly into the

terminal box, but just up to the strain relief device, which in this case should also be fitted externally. This prevents moisture from penetrating into the terminal box.

- ▶ Unscrew the upper section of the strain relief device and release the mounting screws for the lower section. Insert the cable with seal insert into the gland opening. When the cable is positioned concentrically inside the gland opening, screw the strain relief clip together and secure it.

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| Notice | Tighten the clamping screws of the strain relief clip as much as necessary to produce the required effect but not so much as to damage the insulation. The recommended tightening torque is 5 Nm. Retighten the clamping screws after 24 hours. |
|---------------|---|

Internal equipotential bonding

The equipotential bonding between the ground terminal in the terminal box housing and the motor frame is established via the terminal box mounting bolts. The contact points underneath the bolt heads are bare metal and are protected against corrosion.

The standard terminal box cover mounting screws are adequate as potential bonding between the terminal box cover and terminal box itself.

Final checks

Please check that:

- ▶ the electrical connections in the terminal box are tight and are in full compliance with the specifications above,
- ▶ the machine is connected in accordance with the specified direction of rotation,
- ▶ the inside of the terminal box must be clean and free of any pieces of cable,
- ▶ all gaskets and seals are undamaged and properly secured,
- ▶ the pressure relief device (depending on the type of terminal box: either cast-in slots or an overpressure diaphragm). Any damage may only be repaired after prior discussion with the person responsible for the safety of the installation and only by using original-parts.

Then close the terminal box.

3.7 Connecting the earthing conductor

The cross-section of the earthing conductor must correspond with the set-up regulations, i. e. according to IEC/EN 60204-1, with at least 50 % of the line conductor cross-section for cross-sections of $> 35 \text{ mm}^2$ of the live conductor.

If operated in combination with converters, the equipotential bonding has to be made with a flat conductor of 70 mm minimum width.

A hex bolt with a spring-lock washer and a plain washer is located on the stator frame at the marked connecting point for the earthing conductor, suitable for connecting

multi-wire conductors with cable terminals or flat belts with a suitably designed conductor end.

When connecting, please note that:

- ▶ the connecting face is a bare contact and protected against corrosion with suitable material, such as acid-free petrolatum,
- ▶ the spring-lock washer and plain washer are arranged below the screw head,
- ▶ the minimum required thread engagement and the tightening torque for the setscrew are adhered to.

3.8 Connecting the auxiliary circuits

The model descriptions of the attached additional terminal boxes are defined in the motor documentation, including the arrangement of the additional terminal boxes and the respective terminals.

The necessary details for connecting the auxiliary circuits may be derived from the terminal diagram in the interior of the respective lid and from the machine documentation.

Select the connecting cables with consideration to the rated current and the conditions related to the facility (such as the ambient temperature, routing method, etc. according to IEC/EN 60204-1).

At frequency converter operation depending on converter design (type, electromagnetic interference suppression, make) inverter generated noise voltages can occur in different intensities especially at the sensor connection wires. These are highly dependent on the conditions at the place of use (e. g. grounding of machine and converter, shielding of cables, connection of the cable shields to ground and position of the connecting cables in relation to the power cables) and cannot be influenced by the motor itself. Corrective measures must be carried out by the operator.

Internal equipotential bonding

The equipotential bonding between the protective conductor terminals in the terminal box and the motor frame is established through a mounting bolt in the terminal box; the contact location under this bolt head is bare metal and is protected against corrosion.

Final checks

Before closing any of the terminal boxes, please check that:

- ▶ the cables are connected in accordance with the terminal diagram inside the terminal box cover,
- ▶ the inside of the terminal box must be clean and free of any pieces of cable,
- ▶ the cable glands are firmly tightened, and are suitable regarding the degree of protection, type of cable routing, permissible cable diameter etc, and have been mounted in full compliance with the specifications and regulations,

- ▶ the connecting cables are laid without touching the machine, and the cable insulation cannot be damaged,
- ▶ any cable entries which are not used are sealed and the plugs are tightly screwed in (i. e. so that they can only be removed using the suitable tools),
- ▶ all of the seals / gaskets and sealing surfaces of the terminal box are in a good condition,
- ▶ for screw terminals, ensure that all of the terminal screws have been firmly tightened (this also applies to any terminals which are not in use).

3.9 Sleeve bearings

Sleeve bearings are subdivided into bearings with oil lubrication rings and natural or water cooling, bearings with circulating oil lubrication and bearings with hydrostatic jacking.

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|-------------|--|
| Note | With standard bearings, there is no axial guide. It cannot and must not carry axial forces. The axial position is determined by the magnetic center of the stator and rotor of the motor. The axial clearance is specified in the drawing of the motor. On the motor there is a pointer that indicates the magnetic center to allow for axial alignment at a standstill. |
|-------------|--|

The housing of the bearing consists of two parts and it can be opened. The inner bearing shells are spherical and allow self-alignment functionality on the mechanical load and the operational and thermal changes of the motor. Oil lubrication rings may also be present in bearings with circulating oil lubrication for a damage-free shutdown.

Sleeve bearings with natural cooling

Sleeve bearings with natural cooling release their thermal losses over the surface. During the design of the system, it is important to consider that the maximum permissible ambient temperature of the bearing housing is not exceeded. If necessary, the area of the bearing is to be ventilated separately.

Sleeve bearings with water cooling

Water-cooled bearings can be integrated into the general circulation of the motor cooling water. The water speed shall not exceed 1.5 m/sec. If necessary, reduction valves must be used. The water shall work without back-pressure. Observe the instructions in the manual for water-cooled motors and the values indicated on the instruction plate on the motor.

Sleeve bearings with circulating oil lubrication

The oil speed shall not exceed 1.5 m/s for the inlet and 0.15 m/s for the recirculation. The pipes should have equal length. The recirculation pipe should have a slope of at least 15 degrees in order to avoid oil backflow. Otherwise, larger cross-sections must be used.

All components of the oil supply must be clean and oil-resistant. If there is no oil lubrication ring as a reserve in the bearing, a redundant pump is necessary. The inlet side must be fitted with a filter with a rating of 15 to 25 microns and oil pressure reducing valves for an adjustable oil pressure of 0.02 to 0.08 MPa to adjust the oil volume rate of each bearing.

For observation temperature sensors, pressure switches and flow monitors shall be installed if necessary.

The oil temperature in the inlet must not fall below -10 °C.

| | |
|---------------|---|
| Notice | If the lubricating oil is supplied by the lubrication system of a gear unit, then the compatibility of the bearing metal with the lubricant must be tested. |
|---------------|---|

4 Start-up

4.1 Temperature monitoring of the stator winding

- a) PTC thermistors are electronic components with a stamped characteristic bend at a defined temperature. Several hundreds of ohms can be measured below these on the respective terminals (2 terminals per set) and several kilohms above these by using a simple ohmmeter.

| | |
|---------------|--|
| Notice | The measurement current may only equal a few milliamps! Never connect any external voltage (such as 230 V power supply), since the result would be an immediate destruction of the sensitive components and due to arc development, possibly also an irreplaceable winding damage. |
|---------------|--|

Two PTC thermistor sets are frequently included in the windings for larger motors for various temperatures for the advance warning and cut-off. A triggering device must be connected to each set for evaluation, the potential-free relay contacts must be used for the respective motor control circuits. Subsequently changing the temperature values are not possible – only by installing additional PTC thermistor sets on the winding overhang.

- b) Klixons or micro-term switches are thermal switches, which are firmly set, similar a) installed and directly usable for the control circuits by auxiliary contactors. Inspection: No resistance on the respective terminals in the cold state; a passage therefore exists which is interrupted after falling below the defined switching temperature.

| | |
|---------------|--|
| Notice | Such contacts may not switch a greater inductive load – connect auxiliary coils with an R-C snubber element! |
|---------------|--|

- c) Directly displaying thermometers with adjustable threshold value contacts are practically only used for monitoring the bearing temperature. In reference to the contact loading, the protecting method listed under b) applies. For adjusting advices: see final paragraph.
- d) Thermal elements (such as Ni/CrNi) produce a temperature-related thermoelectric voltage according to a specific characteristic curve, which must be analyzed in separate transducers for the temperature display, possibly with threshold value contacts according to c). These temperature sensor are very low-resistance ($m\Omega$) and deliver voltages in the millivolt range. They are used within slide bearings shells, seldom in the winding area.
- e) Resistance thermometers are calibrated temperature measurement resistors (generally with a platinum wire → Pt100 with $100\ \Omega$ at $0\ ^\circ\text{C}$ and $0.385\ \Omega$ resistance change per Kelvin; they have a linear progression: i.e. $138.5\ \Omega$ at $100\ ^\circ\text{C}$ or $153.9\ \Omega$ at $140\ ^\circ\text{C}$). Each thermometer is applied to two (possibly three / four) terminals, possibly combined with overvoltage protection und fuses in an additional terminal box. The

terminals are frequently combined to a joint conductor. As described under a), the resistance determination can be used to check the resistances and the temperature can be calculated by this method according to the appropriate conversion. A suitable measuring amplifier with a signal relay for a separate adjustment of advance warning and cut-off temperature must be used for each resistor (i.e. for Pt100) (these are available for five or eight measuring circuits in one housing – for example, for 3 or 6 units per winding and 2 units per bearing).

| | |
|-------------|--|
| Note | Temperature sensors for monitoring the winding temperatures are located directly in or on the coil and are embedded or glued on in general. Replacement for defective sensors or retrofitting is possible only by gluing on and does not affect the functionality. Possibly temperature deviations from an embedded sensor must be considered. |
|-------------|--|

Determination of the switching values:

1. Maximum cut-off temperatures for the initial setting for the start-up:

Table 4-1 Maximum cut-off temperatures for initial setting

| Windings | Warning | Cut-off |
|--|----------------|----------------|
| Isolation class 155 (F) | 140 °C | 150 °C |
| Isolation class 180 (H) | 160 °C | 170 °C |
| Bearings | Warning | Cut-off |
| Roller bearings | 100 °C | 110 °C |
| Sleeve bearings • Sensor in the bearing shell | 85 °C | 95 °C |
| Sleeve bearings • Sensor in the oil pan | 65 °C | 75 °C |

Any exceeding of these values must be reported to us immediately, in order to discover the cause in time. Higher settings may be permitted in individual cases.

2. The final switching values must be set in reference to really measured operating temperatures after completing the start-up and running-in period of the machine:


Table 4-2 Maximum cut-off temperatures in reference to really measured operating temperatures

| Windings | Warning | Cut-off |
|--|--|--|
| Isolation class 155 (F) | $T + 10 \text{ K} \leq 140 \text{ }^\circ\text{C}$ | $T + 15 \text{ K} \leq 150 \text{ }^\circ\text{C}$ |
| Isolation class 180 (H) | $T + 10 \text{ K} \leq 160 \text{ }^\circ\text{C}$ | $T + 15 \text{ K} \leq 170 \text{ }^\circ\text{C}$ |
| Bearings | Warning | Cut-off |
| Wälzlager | $T + 5 \text{ K} \leq 100 \text{ }^\circ\text{C}$ | $T + 10 \text{ K} \leq 110 \text{ }^\circ\text{C}$ |
| Sleeve bearings • Sensor in the bearing shell | $T + 5 \text{ K} \leq 85 \text{ }^\circ\text{C}$ | $T + 10 \text{ K} \leq 95 \text{ }^\circ\text{C}$ |
| Sleeve bearings • Sensor in the oil pan | $T + 5 \text{ K} \leq 65 \text{ }^\circ\text{C}$ | $T + 10 \text{ K} \leq 75 \text{ }^\circ\text{C}$ |

T = Maximum of measured continuous operation temperature under actual operating conditions, above the operating temperature with consideration to the anticipated maximum ambient air and coolant temperature.

Deviating values may be logical depending on the requirement – if necessary, we will await your consultation.

4.2 Checking the insulation resistance

| | |
|--|--|
|  Danger | <p>During the measurement, and immediately afterwards, some of the terminals are at hazardous voltage levels and must not be touched.</p> <p>If the cables are connected, ensure that the mains voltage cannot be connected. Once you have measured the insulation resistance, discharge the winding by connecting the ground potential.</p> |
|--|--|

| | |
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| Caution | <p>The insulation resistance needs to be checked prior to start-up and again after any extended periods of storage or periods during which the equipment is not in operation.</p> <p>Before you begin measuring the insulation resistance, please read the manual for the insulation resistance meter you are going to use. Any cables of the main circuit which are already connected should be disconnected from the terminals in order to carry out the insulation measurements.</p> <p>Preferably measure the insulation resistance of the winding to the motor enclosure when the winding temperature is between 20 and 30 °C: Different insulation resistance values apply at other temperatures. When making the measurement, you must wait until the final resistance value is reached (approx. 1 minute).</p> |
|----------------|--|

Limit values

The following table indicates the measuring circuit voltage and the limit values for the minimum insulation resistance.

Table 4-3 Isolation resistance at 25 °C

| | measuring dc voltage | Insulation resistance |
|---|-------------------------------|---|
| Extra low-voltage circuits with protective-separation (e. g. temperature sensors) | 250 V | $\geq 0,5 \text{ M}\Omega$ (IEC/HD 60364-6) |
| General equipment up to 1 kV (e. g. heater) | 500 V | $\geq 1 \text{ M}\Omega$ (IEC/EN 60204-1) |
| Windings up to 1 kV | 500 V | $\geq 5 \text{ M}\Omega$ (IEC/EN 60034-27-4) |
| Windings above 1 kV up to 2,5 kV | 500 V (max. 1000 V) | $\geq 100 \text{ M}\Omega$ (IEC/EN 60034-27-4) |
| Windings above 2,5 kV up to 5 kV | 1000 V (max. 2500 V) | |
| Windings above 5 kV up to 12 kV | 2500 V (max. 5000 V) | |
| Windings above 12 kV | 5000 V (max. 10 000 V) | |
| Slip ring systems up to 1 kV | 500 V | $\geq 50 \text{ k}\Omega$ (IEC/EN 60204-1) |
| S Slip ring systems above 1 kV | Rated voltage maximum 5 kV | By arrangement (IEC/EN 60204-11) |

Note the following items:

- ▶ DC voltage shall be used to measure the insulation resistance. The voltage level must be limited to the rated voltage for which the winding is designed and adapted to the condition of the winding. This is especially important for machines in the low voltage range and for moistured windings. Too high voltages can overload the insulation and lead to an insulation fault.
- ▶ The measurement is usually performed with negative polarity to counteract the phenomenon of electrodosmosis in the presence of moisture.
- ▶ No correction is required if the insulation resistance of the winding is 1 min after application of the measuring voltage $> 5 \text{ G}\Omega$ or if the temperature is below 40 °C. Otherwise, the measured value (T in °C) must be converted to the reference temperature of 25 °C in order to be able to compare the values with the table above. The insulation resistance is reduced by a factor of a half for every 10 K increase in temperature, and it is increased by a factor of two for every 10 K decrease in temperature:

$$\text{Minimum isolation resistance} \leq \text{Measured isolation resistance} \cdot 0,5^{\frac{40\text{ }^{\circ}\text{C} - T}{10\text{ K}}}$$

- ▶ New, dry windings have an insulation resistance between 100 and 2000 MΩ, or even higher values. If the insulation resistance is close to the minimum value, then the cause could be humidity and / or dirt accumulation.

▶

| | |
|---------------|---|
| Notice | If the critical insulation resistance is less than or equal to this value, the windings must be dried or, if the fan is removed, cleaned thoroughly and dried. Please note that the insulation resistance of dried, clean windings is lower than that of warm windings. The insulation resistance can only be properly assessed after conversion to the reference temperature of 25 °C. |
|---------------|---|

| | |
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| Notice | If the measured value is close to the critical value, the insulation resistance should be subsequently checked at appropriately frequent intervals. |
|---------------|---|

4.3 Drying

Drying can be accomplished by heating the coils via direct current. However, the current should not be higher than half the rated coil current and the temperature of the coils must be monitored continuously for the respective insulation class (possibly by measuring the Cu resistance increase – therefore measure the cold coil resistance prior to starting the drying process and check it later from time to time).

The standard value for a favourable drying temperature: 1.4 times the resistance increase, if the original temperature was at approx. 20 °C. Change the winding phases frequently! An alternate current can be supplied according to the reduced voltage (approx. 5...6 % of the rated machine voltage) with a fully stopped rotor for drying squirrel-cage induction motors.

Closed types must be opened by removing any coolers or at least in the area of access covers, air gap measurement openings, terminal plates or dummy covers to provide an air exchange – possibly blow through dry air.

In addition, in frequent cases of pure surface moisture alone flowing dry, if necessary heated air (fan heater) can bring the desired effect.

Special attention must be paid for machines with thermal coil protection (PTC thermistors) that the drying temperature remains below 120 °C (this value can be up to 180 °C in motors with insulation class 'H'). PTC thermistors may only be checked with a measuring voltage below 0.8 V.

Slot thermometer Pt100 (100 Ω at 0 °C) provide precise windings temperature measurements in conjunction with calibrated measuring amplifiers and indicating instruments. A check is also possible via a resistance bridge or an ohmmeter with a low measuring current: Resistance change is 0.385 Ω/K; i. e. measured value equal 138.5 Ω matches to a coil temperature of 100 °C.

4.4 Start-up of sleeve bearings

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| Caution | When working on bearings it is important to ensure absolute cleanliness. The oil lubrication rings and seals are to be handled carefully. Damage and deformation are to avoid. |
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| Caution | The running surfaces of the bearing shells are finished and must not be scraped. |
|----------------|--|

The bearings are generally delivered without oil. Before start-up they have to be filled up with oil up to the oil level mark or until the oil returns. Generally, any brand with the given viscosity indicated on the instruction plate on the motor, low foaming and good oxidation resistance can be used as a lubricant. The pour point of the lubricating oil must be at least 10 K below the minimum permissible ambient temperature of the motor.

Before starting motors with bearings with circulating oil lubrication all components have to be washed out and the filter cleaned.

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| Caution | The bearings and measuring devices must not be located inside the rinsing circuit while the external oil supply is rinsed. |
|----------------|--|

For bearings with oil lubrication rings, check that the oil lubrication rings and oil scrappers have been incorporated.

Bearings with hydrostatic oil supply: Switch on and check the flow of oil.

The oil flow rate of the oil lubrication system is set according to the instruction plate on the motor.

After starting the motor, the following values shall be monitored within the first few hours:

- ▶ bearing temperatures,
- ▶ oil tightness,
- ▶ vibrations,
- ▶ run of the oil lubrication ring.

The oil temperature should not exceed 65 °C while the temperature of the bearing shell at the built-in temperature sensor shall not be over 85 °C.

4.5 Measures to be performed prior to commissioning

After assembling the motor in line with technical requirements and before starting up the system, check that:

- ▶ the machine has been properly assembled and aligned,
- ▶ the machine has been connected up in accordance with the specified direction of rotation,
- ▶ the operating conditions comply with the data specified on the rating plate,

- ▶ the bearings have been regreased (depending on model). Rolling-contact bearing motors which have been in storage for more than 2 years must be regreased,
- ▶ any supplementary motor monitoring devices and equipment have been correctly connected and are functioning,
- ▶ if bearing thermometers are fitted, the bearing temperatures are checked during the initial run of the motor and the warning and cut-off values are set on the monitoring device,
- ▶ appropriately configured control and speed monitoring functions ensure that the motor cannot exceed the permissible speeds specified on the rating plate,
- ▶ the drive side elements have the correct parameters for their type (e. g. alignment and balancing of clutches, belt tension of a belt drive, backlash and crest clearance of a gear PTO drive, radial clearance),
- ▶ the minimum insulation resistance values and clearance values are maintained,
- ▶ the earthing and equipotential bonding values have been properly established,
- ▶ any bearing insulation is fitted in accordance with the labelling.
- ▶ all retaining bolts, connecting elements and electrical connections have been tightened to the specified torque,
- ▶ the rotor can spin without coming into contact with the stator,
- ▶ all shock protection measures for moving and live parts have been taken,
- ▶ if the second end of the shaft is unused, its featherkey has been secured so that it cannot fall out and the open shaft end is covered,
- ▶ all separately driven fans fitted are ready for operation and have been connected such that they rotate in the direction specified,
- ▶ the flow of cooling air is not impeded,
- ▶ all brakes are operating correctly,
- ▶ when operated on a converter, the motor can neither exceed the specified speed limit n_{\max} nor under-shoot the specified limit value n_{\min} .

If the design of the motor requires that the converter is a specific assigned type, the rating plate or certificate will contain corresponding additional information.

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| Notice | This list does not claim to be exhaustive. It may be necessary to make additional checks and tests in accordance with the situation specific to the particular place of installation. |
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4.6 Switching high-voltage motors

Overvoltages resulting from switching operations


When putting high-voltage motors or switchgears for high-voltage motors into service (3 kV to 12 kV), attention must be paid to the following because of possible overvoltages:


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|----------------|---|
| Caution | Irrespective of the motor size and regardless of the turn-off principle of the circuit-breaker used, in other words even on small-oil-volume, SF6 or air-blast circuit breakers, shutdowns during motor start-up, for example, caused by faults in the starting control or by oversensitive protection settings, should be avoided if at all possible. Likewise, shut-downs during start-up for checking the direction of rotation or other tests should be kept to the absolute minimum. |
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5 Operation

5.1 Safety instructions

Machine operation

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|  Warning | <p>All covers that are designed to prevent active or rotating parts from being touched ensure compliance with a particular degree of protection, or that are required for ensuring proper air guidance and, in turn, effective cooling must not be opened during operation. All deviations from normal operation (higher power consumption, temperature or vibration level, unusual noises or odours, tripped monitoring devices, etc.) are indications that the motor is no longer functioning correctly. In this case, the maintenance engineer must be immediately notified in order to prevent disturbances that could either directly or indirectly lead to severe personal injury or substantial material damage. If in doubt, power down the motor immediately in accordance with the system-specific safety requirements!</p> |
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|  Warning | <p>The surfaces of the machines can reach high temperatures, which can lead to burns if touched. That is why appropriate measures against accidental contact must be taken.</p> |
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Cleaning

To ensure proper functioning of the machine cooling system, the cooling circuits must be free of pollution (grilles, ducts, ribs, pipes).

5.2 Drives with insulated bearings

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| Caution | <p>In the event that an insulated bearing is installed on the DE side, the local Helmke branch must be consulted prior to any replacements, modifications, maintenance or any other interference in the machine, etc.</p> |
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5.3 Starting

- ▶ Prior to start-up, manually turn the rotor and listen for unusual noises.

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| Caution | <p>The number of permitted starts depends strongly on the driven load. It is to determine for the specific drive system in any case. A too high number of starts or too short cool down phases lead to high temperatures in the machine especially in the rotor and can damage the machine shortly and also long-term. Depending on the machine design it is possible that the integrated temperature sensors (e. g. PTC or Pt100) do not show this. As a guideline a maximum of 1000 starts per year can be obmitted for typical applications.</p> |
|----------------|---|

- ▶ Star-delta start: The switching timer must be set so that the continued switching from star to delta only occurs after exceeding the breakdown torque, therefore after completing the star starting current. Other conditions can be provided in special cases only after consulting us after checking the run-up time, such as for fan drives with a greater moment of inertia.
- ▶ Softstarter: The use of a softstarter reduces the stress of the mechanical parts and for the feeding mains. They can only be used, if the driven load needs low torque during start (e. g. fans with closed air inlet). The acceleration time rises. The thermal heating of the motor is always increased in comparison to direct online start. Respectively the number of permitted starts is reduced.
- ▶ It is recommended to initially idle the motor for one hour, i. e. not connected to the machine. A proper run is present, when no unauthorized vibrations or irregular bearing noises can be noticed. Tapping or knocking noises in the bearing areas lead to the conclusion to bearing damages (transport, extensive downtime). Screeching noises point to slipping rollers, possibly incompletely developed grease film – this can occasionally be observed in idling roller bearings, however, should have disappeared after a brief operating period. In addition to the listening stick or stethoscope for a subjective evaluation by an expert, portable measuring devices SPM 43 A or T 2000 can be applied for the bearing evaluation via the SPM method. Various design models of the motor housings must be considered for the volume of all running noises (cast iron machines always appear to be quieter than welded steel structures with tubular condensers).

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| Caution | Motors with cylindrical roller bearings need a specific minimum bearing load. For vertical machines this is not given without coupled driving elements. An unloaded test run must be carried out in horizontal position or with pressure roller depending on the type of the axial thrust bearing. Otherwise a quick bearing damage may occur. In case of doubt ask the manufacturer. |
|----------------|---|

- ▶ Our motors were also tested for their smoothness of operation prior to delivery. If unexplained vibrations are still encountered, the motor must first be separated from the load machine and restarted to limit the cause. If the smoothness of operation is still unsatisfactory, the clutch or pulley may not correspond with the respective balance condition (half key / full key balancing) of the motor, or the characteristic frequency of the foundation is too close to the motor rotational frequency. In order to properly check the balancing quality of the motor, it would have to be operated with a free shaft and a half (or full) key on a neutral base (such as rubber plates or rubber-bonded metals) or suspended from a crane and the vibration speeds (mm/s) must be measured. According to experience, foundation problems almost only occur in 2-pole motors i. e. drives operating at 3,000 / 3,600 rpm.
- ▶ Coupled and therefore only slightly radially stressed motors sometimes still have unexpected vibrations despite proper balancing. A “jumping” of the rotor within

increased bearing clearance could be the problem. Possible remedy other bearings with a reduced play. For machines with 2 deep-groove ball bearings, of which the one is installed axially movable as movable bearing: Preset this bearing with disk springs or such.

- ▶ Roller bearings receive the required grease quantity of an optimal quality prior to the motor delivery as initial lubrication (request specifications, if necessary).
- ▶ Sleeve bearings are delivered without an oil fill.
- ▶ The lubrication and maintenance instructions must be observed for the roller and sleeve bearings.
- ▶ The temperature of the roller bearings can be up to 50 K above the coolant temperature of 40 °C – higher values up to an operating temperature of 140 °C are possible under certain circumstances after consultation.
- ▶ The operating temperature of sleeve bearings should not be greater than 75 °C during continuous use (approx. 10 K higher, if this measurement is made directly in the lower shell) – contact is necessary for special cases. The temperature of sleeve bearings specifically should be constantly monitored; Pt100 measurement resistors are generally installed there.
- ▶ All machines with removable covers on plug-in type bearings or housings require verification that these remain closed, since a perfect ventilation is otherwise not guaranteed and unauthorized heating may occur.

5.4 Operation

Vibrations according to DIN ISO 10816-3 within the “satisfactory” range ($v \leq 4.5$ mm/s) are inoffensive during the coupled operation. The machine must be switched off in the event of doubts in case of any changes from the normal operation – such as increased temperatures, noises, vibrations. Determine the cause, possibly contact the manufacturer. Safety equipment may not be disconnected even during trial operations. Clean the cooling equipment routinely in case of extensive contamination.

5.5 Stoppages

If the motor remains out of service for an extended period of time (> 1 month), it should be started up about once a month or at least the rotor should be turned. Refer to the instructions in chapter 5.3 – ‘Starting’ on page 5-1 before restarting the motor. If a rotor locking device has been attached to the motor, you must remove it before you spin the rotor.

| | |
|----------------|---|
| Caution | If the motor is not to be used for a period in excess of 12 months, suitable anticorrosion, mothballing, packaging and drying measures must be taken. |
|----------------|---|

Switching on the anti-condensation heating

If an anti-condensation heating is provided, switch it on during the machine stoppages.

Taking the machine out of service

For details of required measures see chapter 3.2 – ‘Storage’ on page 3-2.

Shaft earthing device

If non-standard shaft grounding devices are used at the non-drive end shaft end / bearing unit with brushes in a design that is not encapsulated and sealed, corrosion can occur on the brush track (shaft) during lengthy stoppages. The corrosion must be removed when the machine is put (back) into operation.



Lubrication prior to recommissioning

| | |
|----------------|--|
| Caution | If the motor has not been used for longer than 12 months, it must be regreased before being restarted. The shaft must rotate so that the new grease can be distributed throughout the bearings. Pay attention to the instructions on the lubrication plate. |
|----------------|--|

6 Maintenance

6.1 Preparations for maintenance

Instructions relevant to safety

| | |
|--|---|
|  Warning | <p>Before starting any work on the motors ensure that the plant or system has been deenergised and locked-out against re-closure in full compliance with all of the appropriate specifications and regulations. In addition to the main circuits, also make sure that supplementary and auxiliary circuits are isolated from the supply, especially the anti-condensation heater.</p> <p>Certain parts of the machine may reach temperatures above 50 °C. Physical contact with the machine could result in burn injuries! Check the temperature of parts before touching them.</p> <p>When cleaning the machine, ensure that suitable exhaustion measures are used and you use personal protective gear (e. g. goggles, face mask / filter).</p> <p>If chemical cleaning agents are used, observe the instructions and any warnings indicated on the associated safety data sheets. Chemical agents must be compatible with the motor's components/parts, especially when they contain plastics.</p> |
|  Danger | <p style="text-align: center;">Explosion hazard</p> <p>If you clean the machine with compressed air, plastic components may become statically charged and create a potentially explosive atmosphere. Do not clean plastic components with compressed air. When cleaning the machine, make sure that the air in the vicinity of the motor is free of gas and dust.</p> |
| Notice | <p>Operating conditions and characteristics can vary widely. For this reason, only general maintenance intervals can be specified here.</p> |

6.2 Cleaning the motor

When cleaning the motor, care must be taken above all to clear dirty and possibly blocked airways and cooling surfaces. The machine should be cleaned with dry air (compressed air or bellows). Avoid blowing dust into the bearings. The pressure may not be too high that also no dust forced through the bearing seal.

6.3 Lubrication and maintenance instructions for roller bearings

General

Roller bearings are precision parts. A suitable lubrication is decisive in any case for the operational safety. Low-vibration operation and adherence to the respective bearing loads are an absolute requirement.

The grease quality listed on the lubrication labels must be used for re-lubrication. This prevents bearing damages due to incorrect lubrication use. The mentioned lubrication intervals must also be adhered to; excessively greasing the bearings is also detrimental. Difficult operating conditions may require corrections – we therefore request that you contact us.

| | |
|---------------|---|
| Notice | The bearing grease loses its excellent lubricating characteristics at least after 4 months after the machine shutdown period, if it has not been refilled since the shutdown. |
|---------------|---|

Machines without a grease nipple

The first fill is generally sufficient for the service life of the bearing. If re-lubricating is required after an extended shutdown period, the used grease must be completely removed, whereby the bearing cover and the bearing must be carefully cleaned with gasoline or degreaser. Then coat the roller bearings with fresh grease and fill both bearing covers sufficiently with grease. Excessive grease results in unauthorized heating of the roller bearings and must therefore be avoided at all costs.

A light rotation of the rotors should be checked manually after the bearing covers have been re-attached. An observation during the start-up is recommended: Noises? Excessive heating of the bearings over a longer period?

Machines with grease nipples and without a used grease removal

A reference tag is attached on the motor, on which the grease quantity and the intervals for regreasing are listed. After several times of regreasing, the outer bearing covers must be removed and the used grease must be removed.

A light rotation of the rotors should be checked manually after the bearing covers have been re-attached.

| | |
|---------------|---|
| Notice | Only re-grease the machine while the machine is operating, if necessary, provide lubricating tube extensions. Access tubes must always be filled with grease! |
|---------------|---|

Machines with grease nipple and automatic grease quantity adjustment

Re-grease while machine is running. Reference tags are attached for regreasing. An installed spinner disk hurls the used grease pressed out of the roller bearings, which accumulates in a chamber. These are arranged as follows and will be emptied in the manner listed in the following. Conduct the first check after 2...3 hours. The bearing covers do not have to be dismantled.

- ▶ Grease chamber under the fan cover on the drive end side
→ Remove screws, pull out the grease chamber and empty
- ▶ Grease chamber under the outer bearing cover
→ Pull out the drawer, empty the chamber
- ▶ Grease chamber under the inner bearing cover

- Reach into the bearing end plate opening, pull out the drawer, empty the chamber
- ▶ Horizontal tube under the fan cover on the drive side
 - Unscrew both plugs, push out used grease with a rod

| | |
|---------------|---|
| Notice | <p>Excessive grease quantities may result in increased bearing heating! The excess grease is discharged only after hours. The instructions apply accordingly for other models.</p> <p>Grease with a viscosity of (< 130 cSt) should be used for 2-pole machines due to the high temperatures during the start.</p> |
|---------------|---|

| | |
|---------------|---|
| Notice | <p>We recommend ESSO UNIREX N3 as standard lubricant. Although the bearings are lubricated in the manufacturing plant, the new bearings must be re-lubricated after a few days of operation, in order to guarantee a long service life.</p> <p>If the lubricating intervals become very short due to a high bearing temperature (> 85 °C), high temperature grease should be used.</p> |
|---------------|---|

Machines with automatic re-greasing device

Automatic re-greasing devices are usually used when the bearing load is very high and the lubrication intervals are correspondingly short. They can also be used to define a general maintenance interval independent of the lubricating interval.

A lubricant dispenser provides continuous lubrication over a predefined period of time during operation.

| | |
|----------------|--|
| Caution | Note the details of the re-greasing device manufacturer regarding storage, specific environmental conditions, grease filling, adjustment, operation modes, power supply and supervision. |
|----------------|--|

| | |
|---------------|---|
| Notice | <p>Replace the lubricant reservoir in time. Remove the used grease in the grease chamber depending on the size of the lubricant reservoir, regular lubrication intervals and the respective lubricating volume.</p> <p>Also while using this automatic re-greasing device, pay attention to all instructions in this whole section.</p> |
|---------------|---|

Miscibility

| | |
|----------------|--|
| Caution | <p>When changing from one grease type to another, it is important to observe the miscibility of the greases. If incompatible greases are mixed together, the composition can be changed dramatically and the maximum approved operating temperature of the grease mixture can be so low in comparison to the original grease that bearing damages cannot be ruled out.</p> |
|----------------|--|

Greases that have the same soap and use similar basic oil can generally be mixed without any hazardous results. Grease based on lithium can be mixed with other grease based on lithium. Grease based on calcium and lithium generally can be mixed, however, not with one based on sodium. Mixtures can reduce the drop point of the mixtures. Modern high-performance grease loses its generally good characteristics when mixing with other grease. A perfect operation of the machine should be checked by applying a listening stick or SPM measuring device before and after each lubrication process.

6.4 Maintenance instructions for sleeve bearings

| | |
|----------------|--|
| Caution | When working on bearings it is important to ensure absolute cleanliness. The oil lubrication rings and seals are to be handled carefully. Damage and deformation are to avoid. |
|----------------|--|

The first oil change shall be made after 600 to 700 operating hours. The oil change intervals and oil viscosity are indicated on an instruction plate on the motor. The change intervals are shortened through frequent starts, high lubricating oil temperatures or excessive pollution caused by external influences. Apart from the oil tightness the oil and the oil flow rate, the cleanliness of the filter should be checked regularly.

For an oil change, drain the oil and clean all components. Defective parts and filters should be replaced if necessary. Subsequently, oil is to be filled according to the instructions for start-up. After the start, the bearings have to be monitored according to these instructions (see chapter 4.4 – ‘Start-up of sleeve bearings’ on page 4-7).

The outer bearing housing must be kept clean in order not to disturb the heat transfer through the fins, particularly in naturally cooled bearings.

For water cooling of the bearings, the maintenance instructions of water-cooled machines apply in addition to the above.

6.5 Maintenance instructions for freestanding drives

High voltage machines, which are shut down over an extended period under extreme climatic conditions (room temperature of 40...45 °C and relative humidity of more than 95 %), can still be operated at an insulation resistance of 0.5 MΩ, if they are otherwise clean.

When operating the motors outdoors without a protective roof (only possible for motors with a minimum protection rate of IP44 and a normal climate), an increase maintenance requirement is necessary, especially in case of extended shutdown periods. These motors must be operated for at least one hour monthly to reduce corrosion due to condensate and rain water. When shutting down the motors during winter, blocking the outer fan by snow and ice must be prevented.

6.6 Servicing

6.6.1 Servicing instructions

Faults

An inspection must be carried out as soon as faults or exceptional operating conditions that exert an excessive load (either electrically or mechanically) on the motor (e. g. overload, short circuit) occur.

| | |
|-------------|--|
| Note | When servicing a motor with rolling-contact bearings, it is generally not necessary to dismantle it. The motor only has to be dismantled if the bearings are to be replaced. |
|-------------|--|

| | |
|----------------|--|
| Caution | The required regreasing intervals for rolling-contact bearings are not the same as the servicing intervals. It is essential to adhere to them. |
|----------------|--|

| | |
|----------------|---|
| Caution | The spent grease chambers of the rolling-contact bearings only have enough room to take up a limited amount of spent grease. When the grease chamber is full, you must remove the spent grease before re-lubricating, because it will otherwise escape into the inside of the motor. Escaping oil at the bearing or oil escaping during regreasing is an indicator that the space for the spent grease is full. |
|----------------|---|

6.6.2 First service after installation or repair

After approximately 500 operating hours, at the latest after 1 year

Check, while the motor is running, that:

- ▶ the equipment conforms to the stated electrical characteristics,
- ▶ the permissible bearing temperatures are not exceeded,
- ▶ the smooth running characteristics and motor operating noise have not become worse.

Check, while the motor is at standstill, that:

- ▶ the motor foundation has no indentations or cracks.

Further checks may be required in addition as a result of additional operating instructions or in accordance with the plant-specific conditions. Any impermissible discrepancies or changes found during the checks must be rectified immediately.

6.6.3 General inspection

After approximately 16,000 operating hours, at the latest after 2 years

Check, while the motor is running, that:

- ▶ the equipment conforms to the stated electrical characteristics,
- ▶ the permissible bearing temperatures are not exceeded,
- ▶ the smooth running characteristics and motor operating noise have not become worse.

Check, while the motor is at standstill, that:


- ▶ the motor foundation has no indentations or cracks,
- ▶ the motor is aligned within the permissible tolerance ranges,
- ▶ all of the mounting bolts for the mechanical and electrical connections are tight,
- ▶ the winding isolation resistances are sufficiently high,
- ▶ if the bearings are insulated, the insulation has not been bridged,
- ▶ cables, insulating parts and components are in a good condition and are not discoloured.


6.7 Corrective maintenance

6.7.1 Preparations for overhauling / repairs

Instruction relevant to safety

| | |
|---------------|---|
| Notice | If the motor has to be transported, please observe the information and instructions in chapter 3.1 – ‘Transport’ on page 3-1. |
|---------------|---|

| | |
|---|--|
|  Warning | When working on the locating bearing when the motor is in its vertical position, support the rotor. Pay attention to the following points when attaching rotors: the centring recesses in the shaft ends according DIN 580 eye-bolts are unsuitable because only a few threads would be engaged. Depending on the weight of the rotor and the direction of the load, it may be necessary to use other suitable elements with an engagement length > 0.8 times the thread diameter. |
|---|--|

| | |
|---|--|
|  Warning | Note IEC/EN 60079-19 when carrying out work on explosion protected motors (see chapter 7.5 – ‘Repairs’ on page 7-4). |
|---|--|


6.7.2 Dismantling

The drawings and part lists do not include any detailed data about the type and dimensions of the fixing elements, etc.; when dismantling the motor, you should therefore make a note of where the parts belong and label them so that they can be easily reassembled.

Use pullers or suitable devices to disassemble parts and components attached to the motor shaft. Before you pull off screwed parts and components, replace two of the fixing screws in the top of the parts to be removed by long bolts or stud bolts, so that the parts are still supported after they have been removed.

Bearing bushes

We recommend that you label the components that comprise the active part of the bearing to ensure correct assembly.

| | |
|---|--|
|  Warning | <p>Support or unload the rotor when carrying out work at the thrust bearing with the machine in a vertical position.</p> |
|---|--|

6.7.3 Re-assembly

Sealing

Clean and coat the bare joints between the parts and components (e. g. between housings, end shields and bearing units) with a non-hardening, permanently flexible sealing compound, i. e. Hylomar MQ32 (follow the manufacturer's application and safety instructions!).

Check the existing sealing elements, i.e. at the terminal boxes. Renew them if they no longer provide a proper seal. Only use sealing elements that have been tested!

Installation of the rolling-contact bearings

Before fitting the bearings, ensure that the parts and components to be located on the shaft inside the bearing are fitted first.

Take great care and pay attention to cleanliness when installing and assembling the bearings. To fit the rolling-contact bearings, heat them up to about 80 °C in oil or air and then press them onto the shaft. Avoid any heavy blows that might damage the bearings. Fill the bearings with the specified grease so that they are flush.

6.8 Tightening torque of screw connections

Table 6-1 Tightening torque for screw connections of the electrical connections - terminal board connections (except terminal strips)

| Thread | M4 | M5 | M6 | M8 | M10 | M12 | M16 |
|------------|-----|-----|----|----|-----|-----|-----|
| Torque /Nm | 1,2 | 2,5 | 4 | 8 | 13 | 20 | 40 |

Table 6-2 Tightening torque for screws on the electrical connection box, end plates and protective earth conductor screw connections

| Thread | M4 | M5 | M6 | M8 | M10 | M12 | M16 | M20 |
|------------|----|----|----|----|-----|-----|-----|-----|
| Torque /Nm | 3 | 5 | 9 | 24 | 42 | 70 | 165 | 340 |

Table 6-3 Tightening torque for metal cable glands

| Thread | M12x1,5 | M16x1,5 | M25x1,5 | M32x1,5 | M40x1,5 | M50x1,5 | M63x1,5 |
|------------|---------|---------|---------|---------|---------|---------|---------|
| Torque /Nm | 6 | 7,5 | 9 | 12 | 12 | 14 | 14 |

Table 6-4 Tightening torque for plastic cable glands

| Thread | M12x1,5 | M16x1,5 | M25x1,5 | M32x1,5 | M40x1,5 | M50x1,5 | M63x1,5 |
|------------|---------|---------|---------|---------|---------|---------|---------|
| Torque /Nm | 3 | 3 | 3 | 6 | 6 | 6 | 6 |

6.9 Malfunctions

| Fault | possible cause | Remedy |
|---|--|--|
| Motor does not start | Supply is interrupted | Check the connections, links and terminals and correct, if necessary |
| | Fuse at the input feeder is blown | Search for cause and repair, replace fuse |
| | Motor protection device has been tripped | Check the motor protection device for the proper setting, information regarding power values on the rating plate |
| | Motor protection device does not switch | Check the control of the motor protection device |
| | Fault in the control unit or in the control process | Observe the switching sequence and adjust, if necessary |
| Motor does not start or only starts with difficulty | Motor performance is designed for delta connection, but is switched in star | Change connection from delta to star; observe circuit diagram |
| | Motor performance is designed for double-star connection, but is only switched in star | Change connection from double-star to star; observe circuit diagram |
| | Voltage or frequency greatly deviate from the rated value at least when switched on | Provide better power supply conditions, reduce the load of the power supply, check the cross-sections of the supply wiring, possibly install larger cross-sections |
| Motor will not start in star connection, only in delta connection | Torque for star connection is insufficient | If the starting current is not too high in delta (observe the supplier's specifications), switch on directly in delta Check project engineering and use possibly a larger motor or special type |
| | Contact error on the star-delta switch | Check switch, replace, if necessary; check connections |
| Incorrect direction of rotation | Motor is incorrectly connected | Change two phases of the supply wiring to the motor |
| Motor drones and has a high power consumption | Winding is defective | Motor has to go to repairs in the shop |
| | Rotor touches | |
| Fuses blow or motor protection trips immediately | Short circuit in the supply wiring to the motor | Eliminate short circuit |
| | Supply wirings are incorrectly connected | Adjust connection, observe circuit diagram |
| | Short circuit in the motor | Motor has to go to repairs in the shop |
| | Earth fault on the motor | |
| Great speed reduction under load | Overloading the motor | Measure load, check project engineering, use larger motor, reduce load |
| | Voltage drops | Check cross-sections of the supply wiring, possibly install larger cross-sections |

| Fault | possible cause | Remedy |
|--|--|---|
| Motor heats excessively (measure temperature) | Overload | Conduct performance measurement, check project engineering, use larger motor or reduce load |
| | Insufficient cooling | Improve cooling air supply and clear the cooling air paths, attach external fan, if necessary. Check air filter, clean or replace, if necessary |
| | Ambient temperature is too high | Observe the approved temperature range, possibly reduce load |
| | Motor switched in delta instead of star, as intended | Correct connection, observe circuit diagram |
| | Supply wiring has a loose contact (one phase is missing) | Repair loose contact, check connections; observe circuit diagram |
| | Fuse at the input feeder is blown (one phase is missing) | Search for cause and repair, replace fuses |
| | Supply voltage deviates more than 5 % (range A / 10 % (range B) according IEC/EN 60034-1 from the motor rated voltage. | Adjust motor to the supply voltage |
| | Rated operating mode (S1 to S10, IEC/EN 60034-1) exceeded, i.e. due to excessive switching frequency | Adjust the rated operating mode of the motor to the required operating conditions; possibly consult an expert to determine the proper drive application |
| Noise too high | Ball bearing is braced, contaminated or damaged | Align the motor and the machine, inspect the roller bearings, replace the roller bearings, if necessary |
| | Vibration of rotating parts | Search for cause, possibly imbalance, repair, observe the balancing method |
| | Foreign particles in the cooling air paths | clean cooling air paths |

7 Additional Instructions for Explosion-Proof Motors


7.1 General

The operation of the motors is subject to the regulations for electrical systems in areas subject to a risk of explosions. The requirements according to IEC/EN 60079-14 must be observed when setting up the motors. Determining the degree of the explosion risk of a fixed establishment is exclusively the responsibility of the respective national supervisory authority.


The regulations of the country of use apply for setting up.

7.2 System-specific ignition hazards

The criteria for the respective zonal classification as well as the respective proposed types of ignition protection are not harmonized (e. g. IEC/EN 60079-10-1 and IEC/EN 60079-10-2 as well as IEC/EN 60079-14) and the assessment of the operational risks, the local operating conditions and the various monitoring methods is not uniform and depending on national regulations in the country of use. Accordingly, the remedial measures recommended by the supervisory authorities also differ in some cases, depending on the authority's area of responsibility. The motor manufacturer cannot provide general recommendations in this regard.

| | |
|--|---|
|  Danger | <p>Note the strict compliance with all technical data for the specific motor in the documentation and on the nameplate. Otherwise, it may result in a risk of ignition e. g. by increased temperatures. The information in a certificate of a notified body (e. g. EU type-examination certificate) may be general limits and are subject to specific conditions.</p> |
|--|---|

Motors in type of ignition protection Ex nA

| | |
|---|---|
|  Warning | <p>Binding clarification of the on-site risks and of any required measures can only be provided by the system operator in agreement with the supervisory authority responsible. The risk assessments from standards IEC/EN 60079-14 and IEC/EN 60079-7 resp. IEC/EN 60079-15 must be used to assess the system-specific ignition hazards.</p> |
|---|---|

If the result of the risk assessments is insufficient you must ensure that explosive air does not enter the motor housing during the start-up phase. If this cannot be ensured you are advised to purge the motor housing. The motor is equipped with a purge-air inlet and outlet for this purpose. For information about the purge characteristics and the position of the purge-air inlet and outlet, see the notices on the motor housing. Seal the openings before switching on the motor.

Motors in closed design without pre-purging

Due to the closed design of the machine housing, the interior is not connected to the ventilation requirements at the set-up location of the machine. This means that the possibility exists that the criteria for the classification of the zone according to IEC/EN 60079-10-1 are not in compliance in the interior of the machine housing.

In order to prevent an explosive atmosphere from penetrating or being drawn into the motor frame during stoppages or short-term shutdowns, it may be advisable to initiate suitable measures after shutdown in agreement with the supervisory authorities, such as generating an overpressure (recommended: ≥ 50 Pa; ≥ 0.5 mbar) inside the frame to compensate for leakage losses, or providing suitable ventilation of the installation site (see information notes in IEC/EN 60079-10-1). A tapped hole may be provided in the intermediate housing under the main terminal box for connecting a pipe to prevent a negative pressure being created inside the motor frame. The tapped hole is labelled with a plate and sealed with a screw plug.

7.3 Assembly and connection

Observe the requirements in IEC/EN 60079-14.

Protection against increased temperature

To maintain the thermal class the machine must be equipped with a functionally-tested protection device that disconnects all three phases simultaneously.

A current-dependent time-delayed protection device must trip within 2 hours at 1.2 times rated current of the machine. At 1.05 times rated current it must not trip. They are also being chosen so that the motor is thermally protected even in case of a short circuit (i. e. a locked rotor).

If winding and bearing temperature are monitored, the sensors must be connected to functionally-tested tripping units. Intrinsically safe circuits are clearly marked, possibly colour-coded in light blue. The respective operating instructions of the components must be observed. Unused connection cables are to ground.

Check always the bearing temperature at start-up.

Only the on the nameplate or in the technical data specified thermal class (in case of specification of two classes, the smaller one) or maximum temperature difference must be used.

Unless otherwise stated on the nameplate or in the specifications, the voltage-frequency limits of the zone A in IEC/EN 60034-1 applies.

Anti-Condensation heater

The supply of an anti-condensation heater must be independent from the motor supply. The voltage must conform to the specified in the documentation and on the nameplate. The anti-condensation heater must not be switched on when the motor is in operation.

Cable entries

The make of cable entries depend on the connection method and scope of the order. Cables, wires, sealing, glands and area of use must be coordinated.

The used components must be certified and labeled as being suitable for utilization in the appropriate zone with the necessary IP class and ignition protection type. Not used entries must be closed by qualified and if required certified components. Note that the installation and operation conditions possibly specified in the respective certificate must be observed and check that this is the case.


Frequency converter operation

All rules of IEC/EN 60079-14 must be observed in particular concerning the operation on an inverter. In general, a close coordination with HELMKE is required.

Motor with external fan

For a motor with external fan must be ensured that the motor can only be switched on when the external fan is in operation. The fan drive itself must have the corresponding needed type of ignition protection for the appropriated zone and subject to all the information in this manual.

Purging

| | |
|---|--|
|  Warning | <p>Air may be used as the protective gas, which satisfies the requirements of the Ex p system manufacturer. If a protective gas other than air is used, special care must be taken to prevent the operating personnel from being harmed by the gas escaping under field conditions during purging and operation.</p> |
|---|--|

Terminal boxes in type of ignition protection Ex d

Depending on specific requirements regarding the national laws and rules in the country of use the electrical installation must be done by specific educated staff.

| | |
|----------------|--|
| Caution | <p>Open the terminal box with care and using the proper tools to avoid any even small damages or deformation of the flameproof joints and crossings.</p> |
|----------------|--|

Please note that all flameproof joints must not have damages at any time. Every part with rust or damaged areas must be replaced by original parts. Areas of flameproof joints shall be protected by oil or grease against corrosion.

| | |
|----------------|--|
| Caution | <p>The cable connection must always be done via certified cable entries with type of protection flameproof enclosure Ex d. Note IEC/EN 60079-14.</p> |
|----------------|--|

Terminal boxes in type of ignition protection Ex e

If the machine is equipped with terminal boxes by the type of protection increased safety for both the main terminal box and the auxiliaries aware:.

| | |
|----------------|---|
| Caution | The cable connection must always be done via certified cable entries with type of protection increased safety Ex e. Note IEC/EN 60079-14. |
|----------------|---|


Terminal boxes in type of ignition protection Ex t

If the machine is equipped with terminal boxes by dust ignition protection by enclosure Ex t for both the main terminal box and the auxiliaries aware:.

| | |
|----------------|---|
| Caution | The cable connection must always be done via certified cable entries with dust ignition protection by enclosure Ex t. Note IEC/EN 60079-14. |
|----------------|---|

7.4 Operation

Cleaning the motor

| | |
|--|--|
|  Warning | If the motor is tagged with markings regarding the risk of electrostatic charges e. g. "WARNING – POTENTIAL DANGER OF ELECTROSTATIC CHARGE – READ SAFETY INSTRUCTIONS", no cleaning with compressed air or bellows is admissible in areas subject to a risk of explosions. The cleaning must be made manually using a damp cloth. Avoid process-related static charges. |
|--|--|

Check bearing condition

Carry out occasional vibration monitoring to check bearing condition. Replace when deterioration is detected.

7.5 Repairs

For overhauling and repair a service center must be chosen, which has knowledge of all specific requirements regarding the national laws and rules in the country of use.

All relevant parts regarding the ignition protection must be generally replaced by original spare parts in accordance with the certification documents. This applies particularly to e. g.:

- ▶ screws (identical strength class e. g. class 8.8 or class 12.9)
- ▶ replacement of seals, repair of flame proof joints and crossings
- ▶ repair or replacement of fans or fan covers,
- ▶ bearing replacements,
- ▶ replacement of the terminal elements,
- ▶ change of cable glands,
- ▶ replacement of heaters,
- ▶ new painting.


All changes regarding the ignition protection e. g. modifications of the windings must be agreed by the manufacturer or in an exceptional case with the notified body.

All overhauling and repair activities have to be documented and the machine must be labeled with an additional plate.


IEC/EN 60079-19 gives general instructions for equipment repair, overhaul and reclamation. For the reassembly consider IEC/EN 60079-14.

7.6 Bridging the bearing insulation

A bearing insulated on the DE side is generally bridged electrically conductive, in order to maintain the rotor at the housing potential.

| | |
|---|---|
|  Warning | <p>Removing the factory installed existing bridging of the insulated DE bearing results in potential differences between the rotor and the grounded machine. This may produce sparks, which will ignite the surrounding gas especially in an atmosphere subject to explosions. There is also a risk of electric shock.</p> <p>The bridging of the bearing insulation on the DE side may not be opened during operation.</p> |
|---|---|

The shaft is ground on the DE or NDE side via a shaft grounding device on special models, also during the operation on the converter.

| | |
|---|---|
|  Warning | <p>The bridging of the insulated bearing in models with shaft grounding devices and insulated bearings on the DE and NDE side results in electrical current flow via the machine housing.</p> <p>The bearing insulation of the insulated bearings may not be electrically bridged during operation. Keep the insulation points clean.</p> |
|---|---|



EU-Konformitätserklärung *EU Declaration of Conformity*

Die Firma: J. Helmke & Co.
The company: Ludwig-Erhard-Ring 7-9
31157 Sarstedt

erklärt als verantwortlicher Hersteller, dass
declares as responsible manufacturer, that

die Produkte: 3-Drehstrommotor, **Helmke**
the products: 3-phase induction motors, **HELMKE**

Type: **.NDKK...**

Der folgenden grundlegenden Richtlinie entspricht:
is in conformity with the following Directive:

ATEX Richtlinie 2014/34/EU
ATEX Directive 2014/34/EU

Angewendete Normen:
Applied harmonized standards:

EN IEC 60079-0:2018/AC:2020-2, EN IEC 60079-7:2015/A1:2018

Diese Erklärung erfüllt die Anforderungen der EN ISO/IEC 17050-1:2010 für eine Bestätigung durch die erste Seite.

This declaration meets the requirements of EN ISO/IEC 17050-1:2010 for an attestation by the first party.

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften im rechtlichen Sinne.

This declaration certifies the conformance with the above mentioned directives. Affirmation of attributes in a legal sense is not included.

Die Sicherheitshinweise der zugehörigen Produktdokumentation sind zu beachten.

The safety instructions given in the product documentation have to be observed

Dr. Ralf Briest

Ort / Datum: Sarstedt, 31. März 2022
Place / Date: Sarstedt, March 31st, 2022

Leiter Technik
Technical Director



Erklärung für den Einbau einer unvollständigen Maschine *Declaration of incorporation of partly completed machinery*

nach Anhang II, Teil 1, Abschnitt B der EG-Richtlinie 2006/42/EG Maschinenrichtlinie
in accordance with Annex II, Part 1, Section B of EC Directive 2006/42/EC Machinery Directive

Die Firma
The manufacturer J. Helmke & Co.
Ludwig-Erhard-Ring 7-9
31157 Sarstedt / Germany

bestätigt für
confirms for

die Produkte
the products: 3-Drehstrommittelspannungsmaschine, HELMKE & HELMKE pro
3-phase, medium voltage machine, HELMKE & HELMKE pro

Typ: .D..., .DS..., .DY...
Type:

Spannung: > 1000 V
Voltage:

- die Anwendung und Einhaltung folgend genannter Sicherheits- und Gesundheitsanforderungen nach Anhang I der Richtlinie 2006/42/EG des Europäischen Parlamentes und Rates vom 17.5.2006:
the application and observance of the following specified health and safety requirements according to Annex I of Directive 2006/42/EC:
1.1.2, 1.1.3, 1.1.5, 1.2.6, 1.3.1, 1.32, 1.3.3, 1.3.4, 1.3.7, 1.3.8.1, 1.5.1, 1.5.2, 1.5.4, 1.5.5, 1.5.6, 1.5.8, 1.5.9, 1.5.10, 1.5.13, 1.5.15, 1.6.1, 1.6.5, 1.7.1, 1.7.2, 1.7.4
- die Erstellung der speziellen technischen Unterlagen gemäß Anhang VII, Abschnitt B der EG Richtlinie 2006/42/EG.
compiling relevant technical documentation according to Annex VII, Section B of the EC Directive 2006/42/EC.

Wir erklären, dass die folgend genannte Person bevollmächtigt ist, die relevanten speziellen technischen Unterlagen zusammenzustellen und im Bedarfsfall auf begründetes Verlangen den einzelstaatlichen Stellen zu übermitteln.

We declare that the following person is authorized to compile the relevant technical documentation and to provide the national authorities when necessary to a reasoned request.

Name / *Name:* Dr.-Ing. Ralf Briest
Anschrift / *Address:* Ludwig-Erhard Ring 5-9, 31157 Sarstedt / Germany
Form der Übermittlung / *Form of transmission:* digital



Angewendete Normen:

By design, the machines, considered as components, comply with the essential requirements of the:

| Titel / title | VDE / DIN EN / EN / ISO / IEC |
|--|---|
| Sicherheit von Maschinen – Allgemeine Gestaltungsleitsätze – Risikobeurteilung und Risikominderung <i>Safety of machinery – General principles for design, risk assessment and risk reduction</i> | DIN EN ISO 12100:2011 EN ISO 12100:2010 ISO 12100:2010 |
| Elektrische Ausrüstung von Maschinen – Sicherheit von Maschinen <i>Safety of machinery – Electrical equipment of machines</i> Teil 1: Allgemeine Anforderungen, <i>Part 1: General requirements</i> | VDE 0113-1:2007/A1:2009 DIN EN 60204-1:2007/A1:2009 EN 60204-1:2006/A1:2009 IEC 60204-1:2005/A1:2008 |
| Elektrische Ausrüstung von Maschinen – Sicherheit von Maschinen <i>Safety of machinery – General principles for design, risk assessment and risk reduction</i> Teil 11: Anforderungen an Hochspannungsausrüstung für Spannungen über 1000 V Wechselspannung oder 1500 V Gleichspannung aber nicht über 36 kV <i>Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c and not exceeding 36 kV</i> | VDE 0113-11:2001 Berichtigung 1:2010 DIN EN 60204-11:2001 Berichtigung 1:2010 EN 60204-11:2000 CENELEC-Cor.:2010 IEC 60204-11:2000 |

Diese Produkte sind zum Einbau in eine Maschine vorgesehen. Ihre Inbetriebnahme ist so lange untersagt ist, bis festgestellt wurde, dass die Maschine, in die die elektrische Maschinen eingebaut werden sollen, den Bestimmungen der Richtlinie 2006/42/EG Anhang II, Teil 1, Abschnitt A entspricht.

This product is designed for incorporation into machinery. Bringing into service is prohibited until the machinery into which the electrical machine have been incorporated was declared in conformity with the Machinery Directive Annex II, Part 1, Section A.

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften im rechtlichen Sinne.

This declaration certifies the conformance with the above mentioned directive. Affirmation of attributes in a legal sense is not included.

Die Sicherheitshinweise der zugehörigen Produktdokumentation sind zu beachten.

The safety instructions given in the product documentation have to be observed.

Dr. Ralf Briest

Ort / Datum: Sarstedt, 17. April 2019
Place / Date: Sarstedt, April 17th, 2019

Leiter Technik
Technical Director

Three-phase induction motor with squirrel cage rotor
 Drehstromasynchronmotor mit Kurzschlußläufer

Electrical data / Elektrische Daten

| | | | | |
|--|-------------------------|-------|-------|-------|
| Rated motor power / Bemessungsleistung | kW | 1340 | | |
| Rated motor voltage / Bemessungsspannung | V | Y | 6000 | |
| Rated voltage tolerance / Bemessungsspannungsbereich | Zone A (V: ±5%; f: ±2%) | | | |
| Rated frequency / Bemessungsfrequenz | Hz | 50 | | |
| Number of poles / Polzahl | 2 | | | |
| Rated motor speed / Bemessungsdrehzahl | rpm | 2984 | | |
| Rated motor current / Bemessungsstrom | A | 150 | | |
| Power factor / Leistungsfaktor (at / bei 100% - 75% - 50%) | | 0,90 | 0,89 | 0,84 |
| Efficiency / Wirkungsgrad (at / bei 100% - 75% - 50%) | | 96,1% | 96,3% | 95,8% |
| Breakdown-/Rated torque / Kipp-/Bemessungsmoment (Tb/Tn) | 2,5 | | | |
| Starting-/Rated torque / Anzugs-/Bemessungsmoment (Ts/Tn) | 0,6 | | | |
| Starting-/Rated current / Anzugs-/Bemessungsstrom (Is/In) | 5,5 | | | |

Mechanical data / Mechanische Daten

| | | | | |
|---|---------------------------------------|------|--|--|
| Weight / Gewicht | kg | 5200 | | |
| Rotor inertia / Rotorträgheitsmoment | kgm ² | 16,0 | | |
| Direction of rotation (from DE side) / Drehrichtung (von A-Seite) | clockwise / rechts | | | |
| Balance / Wuchtart | Half-key / Halbkeil | | | |
| Vibration grade / Schwinggrößenstufe | A | | | |
| Bearing / Lagerart | Sleeve bearings with self lubrication | | | |
| Bearing type DE / Lagertyp AS | EMZLB 09S-100 | | | |
| Oil content DE / Öl-Inhalt AS | l | 2,9 | | |
| Bearing type NDE / Lagertyp BS | EMZLB 09S-100 (isoliert/insulated) | | | |
| Oil content NDE / Öl-Inhalt BS | l | 2,9 | | |
| Lubricating oil / Schmieröl | DIN 51517-CL/CLP / VG 22 (ISO 3448) | | | |

General data / Allgemeine Daten

| | | | | |
|---|------------------------------------|------|--|--|
| Frame size / Baugröße | 450 | | | |
| Type of construction / Bauform | IM B3 | | | |
| Material of housing / Gehäusematerial | Welded steel / Stahl geschweißt | | | |
| Material of terminal box / Klemmenkastenmaterial | Welded steel / Stahl geschweißt | | | |
| Degree of protection / Schutzart | IP55 | | | |
| Method of cooling / Kühlart | IC611 | | | |
| Thermal class - temperature rise / Wärmeklasse - Erwärmung | F/B | | | |
| Duty type / Betriebsart | S1 | | | |
| Sound pressure level, no load at 1 m / Schalldruckpegel, Leerlauf bei 1 m | dB(A) | 78+3 | | |
| Painting / Anstrich | RAL 5010 | | | |
| Standards / Normen | EN 60034-1; EN 60079-0; EN 60079-7 | | | |
| Ex-Protection / Ex-Schutz | Ex ec IIC T3 Gc | | | |

Site conditions / Aufstellbedingungen

| | | | |
|---|----|------|-----|
| Ambient temperature / Umgebungstemperatur (min / max) | °C | -5 | +50 |
| Max. altitude above sea level / Max. Höhe über NHN | m | 1000 | |

Accessories / Zubehör

| | | | | |
|--|---|-----------------------|---|-----|
| Thermal protection / Temperaturüberwachung | | 6 + 2 x PT100 / PT100 | | |
| Space heater / Stillstandsheizung | V | 230 | W | 500 |
| Space heater bearings / Stillstandsheizung Lager | V | | W | |

The rating plate values may vary from the calculated values. / Abweichungen zwischen berechneten und Leistungsschilddaten sind möglich.

| | | | | | | | |
|--------------|----------------|----------|----------|---------|----------|--------|-------|
| Type | Identification | Prepared | Date | Checked | Revision | Status | Sheet |
| NDKK450-02-G | 11000101138-39 | Gae | 16.03.23 | PR | 01 | C | 1/2 |

Accessories / Zubehör

Winding: 6 x RTD's Pt100 ohms at 0°C, 2 to 4-wire, with transmitters (2/phase)
Bearings: 2 x double RTD's Pt100 ohms at 0°C, 2 to 4-wire, with transmitters (1/bearing)
Space heater: 230 V / 500 W
Number of consecutive starts cold/hot: 3/2
Starting method: DOL
Application: screw compressor

| Type | Identification | Prepared | Date | Checked | Revision | Status | Sheet |
|--------------|----------------|----------|----------|---------|----------|--------|-------|
| NDKK450-02-G | 11000101138-39 | Gae | 16.03.23 | PR | 01 | C | 2/2 |



PRÜFUNGSNACHWEIS / TEST CERTIFICATE

| | | | |
|-----------------------------------|------------|----------------|---------|
| Fabrikat Make | | HELMKE | |
| Type | | NDKK450-02-G | |
| KLH | Nr. No. | 11000101138 | |
| Y 6000 V | | 150,0 A | |
| 1340 kW | cos φ | | 0,90 |
| ==> 2984 min ⁻¹ rpm | | 50 Hz | |
| U ₂₀ | V | I ₂ | A |
| WkI Th.Cl | F | IP 55 | 5200 kg |
| Ex_ec_IIC_T3_Gc | | EN 60034-1 | |
| -5°C ... +50°C 1000m | | | |

| | |
|-------------------------------|---|
| Kunde / Customer | DELTA GmbH |
| Auftrag - Nr. / Order-no. | 11042200559 |
| Ident - Nr. / Ident - no. | 11000101138 |
| Maschinenart / Kind | 3-Ph - KI - Mot. / 3-ph - sqc - mot. |
| Lager Bearings | AS / DE EMZLB 09S-100 |
| Schmierfrist Relubrication | AS / DE 2,9L |
| Lager Bearings | BS / NDE EMZLB 09S-100 (isoliert/insulated) |
| Schmierfrist Relubrication | BS / NDE 2,9L |
| Kühlart Cooling | IC 611 |
| Betriebsart Duty type | S1 |
| Bauform Frame type | IM B3 |

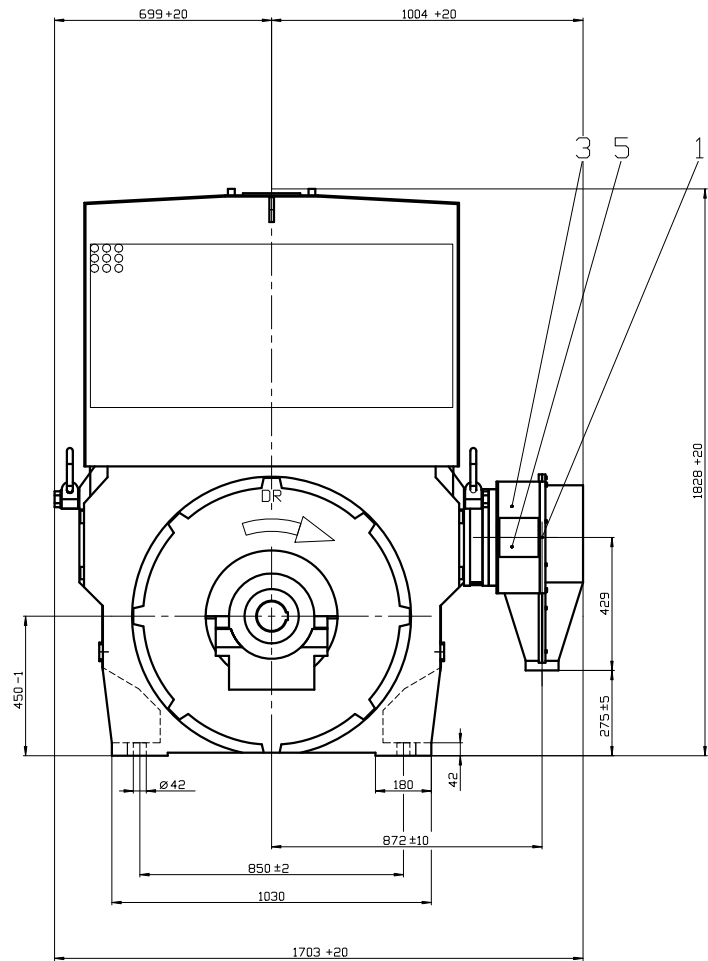
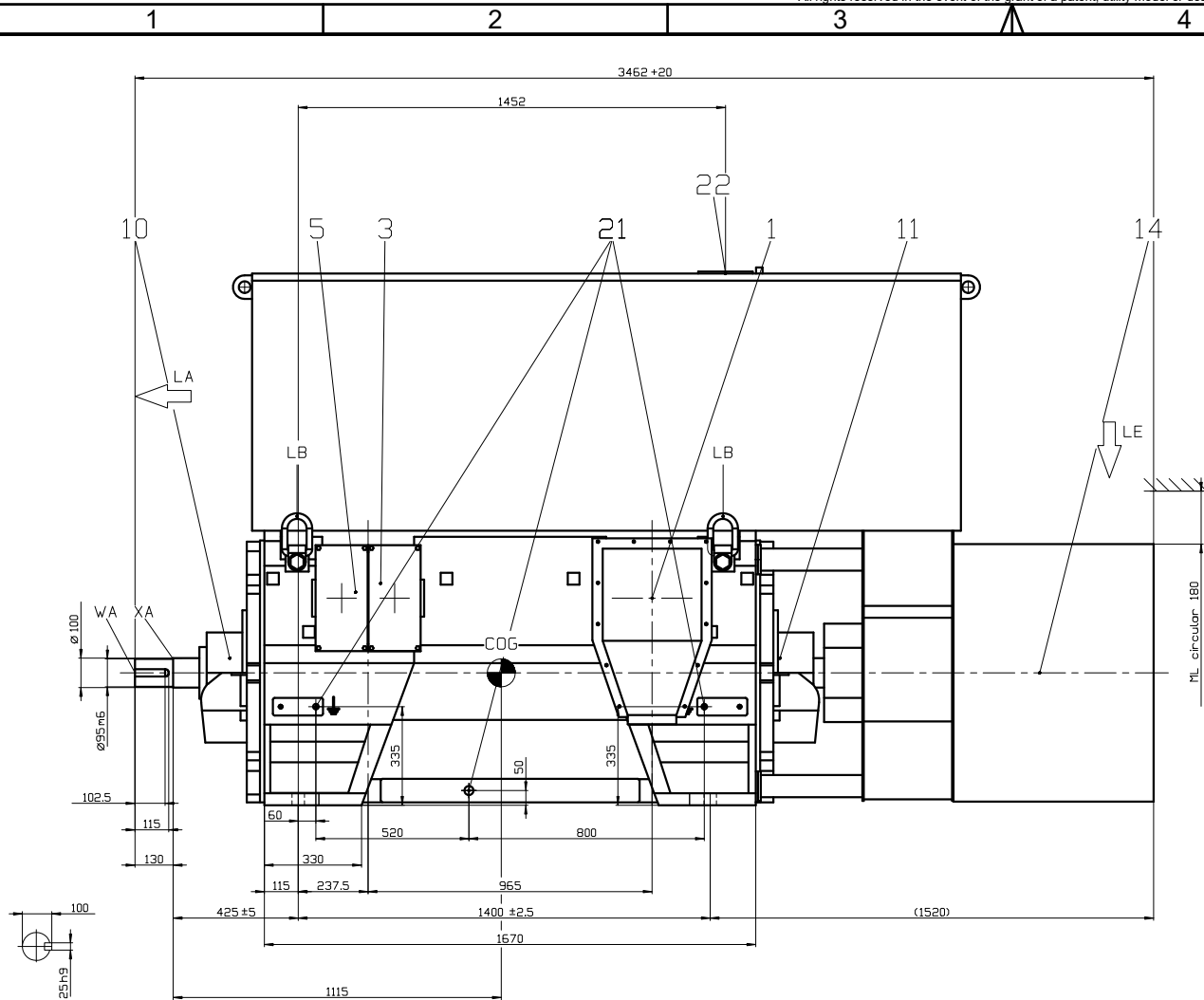
Prüfungen / Tests


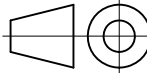
| | | | | | |
|---|-----------------|--|---------------------------|--------------------------|-----------|
| Wicklungswiderstände bei Winding resistance at | 17,2 °C | Stator | U1 - V1; U1 - W1; V1 - W1 | 260 / 260 / 260 m Ω | |
| | | Rotor | | Ω | |
| Isolationswiderstand Insulation resistance | | Stator | 10000 MΩ | 5 kV | |
| | | Rotor | MΩ | kV | |
| Hochspannungsprüfung High-voltage test | | Stator | 13 kV | 60 sek / sec | |
| | | Rotor | kV | sek / sec | |
| Leerlaufprüfung No - load test | | 6600 V | 38,83 / 39,12 A | 25,0 kW | |
| | | 6000 V | 28,93 / 29,14 A | 20,7 kW | |
| Übersetzung / Ratio | | U _{stat} V / U _{rot} V | | | |
| Windungsschlußprüfung mit offenem Rotor Interturn test with open rotor | | | V | Hz min | |
| Kurzschlußprüfung Short - circuit test | 1572,0 V | 180,06 / 181,65 A | 50,5 kW | 50 Hz | |
| | 1330,6 V | 150,15 / 151,43 A | 35,6 kW | 50 Hz | |
| | 1080,9 V | 120,47 / 121,49 A | 22,9 kW | 50 Hz | |
| | 561,4 V | 60,60 / 61,09 A | 5,9 kW | 50 Hz | |
| Lagermessung (SPM) Bearing - measurement (SPM) | dB _i | AS / DE | dB _N | BS / NDE dB _N | |
| Wellenspannung Shaft voltage | mV | bei at | V | | |
| Schwingungsprüfung / Vibration test | | | Horizontal | Vertikal | Axial |
| Wuchtung / Balance | H | <input checked="" type="checkbox"/> | F | <input type="checkbox"/> | |
| | | AS / DE | 1,30 mm/s | 1,30 mm/s | 0,80 mm/s |
| | | BS / NDE | 1,70 mm/s | 1,60 mm/s | 0,80 mm/s |

Bemerkung / Notice:

PT100 Wicklung / PT100 winding 4 x 106,8 Ohm ; 2 x 106,7 Ohm
PT100 Lager / PT100 bearing AS / DE 2x 106,9 Ohm ; BS / NDE 2x 106,9 Ohm
Heizung Isolationswiderstand / heater insulation resistance 10000 MOhm @ 500 V
Heizung / Heater 127,0 Ohm
Lager BS isoliert / bearing NDE insulated

Sarstedt, 14.03.2023 / DT




| | | | | | | | | |
|-----------------------------------|---|------|-----------------------|-------------------------|----------------|---|----|--------|
| B | - | - | - | - | | | | |
| A | Rev.01 | Gae | Pr | Pr | | | | |
| Rev. | Modification | Sign | Controller | Approval | | | | |
| | | | | Date | | | | |
| | | | | 13.03.2023 | | | | |
| All dimensions are in millimeters |  J. Helmke & Co. www.helmke.de | | Identification number | | 11000101138-39 | | | |
| | | | Name | | NDKK450-02-G | | | |
| | Designers | | Date | | Revision | | | |
| | Creator | Gae | 25.04.2022 | ISO tolerances | |  | | |
| | Controller | Pr | 13.03.2023 | ISO 2768-mK ISO 1302 | | | | |
| Approval | | | Material | | Scale | Format | A4 | Status |


Technical data for configuration

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| | | | | |
|---|--|-------------|---------------|-------|
|  | Document type | Created by | | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G Serial-No. : 11000101138-39 | GAE | PR | |
| | | Rev. | Date of issue | Sheet |
| | | | 2022-04-07 | 1/23 |


| | | |
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| | | | | |
|---|--|-------------------|-----------------------------|---------------|
|  | Document type Technical data for configuration | Created by GAE | | |
| | Title | Approved by PR | | |
| | Type : NDKK450-02-G Serial-No. : 11000101138-39 | Rev. | Date of issue 2022-04-07 | Sheet 2/23 |

1 Legend for machine dimension drawing

| Position | Designation |
|----------|---|
| COG | Center of gravity |
| DR | Direction of rotation |
| LA | Air discharge |
| LB | Attachment eye (self aligning) |
| LE | Air intake |
| ML | Maintain minimum clearance air intake and/or air outlet |
| WA | DE shaft end |
| XA | Undercut DE |
| ⊥ | Ground connection |

| Position | Designation |
|----------|--|
| 1 | Terminal box stator line connection |
| 3 | Terminal box auxiliary circuits |
| 5 | Terminal box anti-condensation heating |
| 10 | Sleeve bearings DE |
| 11 | Sleeve bearings NDE |
| 14 | Air intake sound absorber |
| 21 | Connection for purge air intake |
| 22 | Connection, purge air outlet |

| | | | | |
|---|----------------------------------|-------------|---------------|-------|
|  | Document type | Created by | | |
| | Technical data for configuration | | GAE | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G | PR | | |
| | Serial-No. : 11000101138-39 | Rev. | Date of issue | Sheet |
| | | | 2022-04-07 | 3/23 |

2 Technical data

2.1 Mechanical data

| | |
|------------------------------|--|
| Type of construction | IM B3 / IM 1001 |
| Total weight | See dimension drawing |
| Weight of the cooler housing | 0.67 t |
| Rotor weight | See Shaft dimension drawing |
| Rotor balancing | Dynamically balanced with half a feather key, without coupling half |

2.2 Ambient conditions

| | |
|----------------------|--------------|
| Degree of protection | IP55 |
| Cooling method | IC611 |
| Ambient temperature | -5 ... 50 °C |

2.3 Vibration behavior

The values are valid for measurements taken in the manufacturer's test field.
These are valid for rated speed.

Without coupling half

Converter-fed motors are tested as standard the same as line motors.

Bearing housing vibration

| | |
|--------------------------------|-------------------------------|
| Vibration severity grade | A (DIN EN IEC 60034-14:2019) |
| Vibration velocity (rms value) | 2.3 / 2.8* mm s ⁻¹ |

* See also DIN EN IEC 60034-14:2019, Section 8.2

2.4 Shaft end

DE shaft end


| | |
|----------------------------|---------------------|
| Dimension drawing position | WA |
| Centering bore | DR M24×50 - DIN 332 |

Undercut

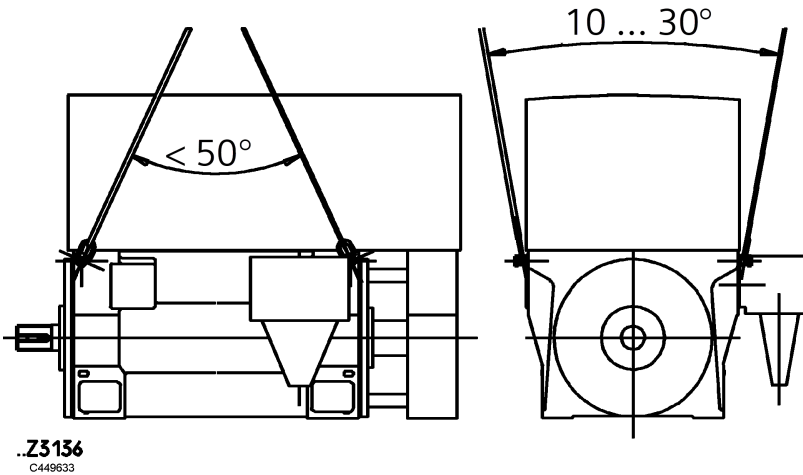
| | |
|----------------------------|--------------------|
| Dimension drawing position | XA |
| Design | E2.5×0.4 - DIN 509 |

2.5 Paint finish

| | |
|----------------------------|----------|
| Standard paint finish | |
| Color | RAL 5010 |
| Total paint coat thickness | 100 µm |

| | | | | |
|---|--|-------------------|-----------------------------|---------------|
|  | Document type Technical data for configuration | Created by GAE | | |
| | Title | Approved by PR | | |
| | Type : NDKK450-02-G Serial-No. : 11000101138-39 | Rev. | Date of issue 2022-04-07 | Sheet 4/23 |

2.6 Lifting and transporting



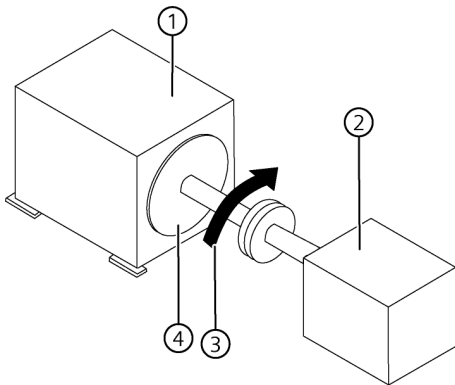
Lifting the machine, attachment points

The following applies when lifting:

Velocity $v < 20 \text{ m min}^{-1}$; Acceleration $a < 0.4 \cdot g$

The attachment points at the machine are only designed to lift the weight of the machine itself. Do not lift the machine together with base frames, adapter or sole plates.

2.7 Direction of rotation



- ① Motor
- ② Driven machine
- ③ Direction of rotation
- ④ DE

Dimension drawing position

DR

Direction of rotation

only clockwise rotation viewed at the DE

Connection, clockwise rotation

| | | | |
|--|----|----|----|
| Line phases in their associated phase sequence | L1 | L2 | L3 |
| at the machine terminals | U | V | W |

| | | | |
|--|--|-------------------|-----------------------------|
| | Document type Technical data for configuration | Created by GAE | |
| | Title | Approved by PR | |
| | Type : NDKK450-02-G Serial-No. : 11000101138-39 | Rev. | Date of issue 2022-04-07 |
| | | | Sheet 5/23 |

2.8 Purging

see the Operating Instructions

| | |
|----------------------|---|
| Overpressure Housing | Max. 50 mbar |
| Flow rate | Min. 150 m ³ h ⁻¹ |
| Purging volumes | 37.5 m ³ |
| Purging time | Min. 15 min |

The final operational values are stamped on the purging plate attached to the machine. The purge plate is only created after measurement.

2.9 Bearing DE

Sleeve bearings

| | |
|----------------------------|--------------------------------|
| Dimension drawing position | 10 |
| Type | EM-ZLB 09S100 12-100 10-100 |
| Manufacturer | RENK |
| Lubricating oil | DIN 51517-CL/CLP |
| Viscosity class | VG 22 (ISO 3448) |
| Scope of delivery | Without oil |
| Changing the oil | Only with the shaft stationary |

Oil ring lubrication

| | |
|--------------|-------|
| Oil quantity | 2,9 L |
|--------------|-------|

Additional details are provided in the associated Operating and Maintenance Instructions.

2.10 Bearing NDE


Sleeve bearings

| | |
|----------------------------|--------------------------------|
| Dimension drawing position | 11 |
| Type | EMkZLB 09S100 12-100 10-100 |
| Manufacturer | RENK |
| Lubricating oil | DIN 51517-CL/CLP |
| Viscosity class | VG 22 (ISO 3448) |
| Scope of delivery | Without oil |
| Changing the oil | Only with the shaft stationary |


Oil ring lubrication

| | |
|--------------|-------|
| Oil quantity | 2,9 L |
|--------------|-------|

Additional details are provided in the associated Operating and Maintenance Instructions.

| | | | | |
|---|-----------------------------|-------------|---------------|-------|
|  | Document type | Created by | | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G | Rev. | Date of issue | Sheet |
| | Serial-No. : 11000101138-39 | 01 | 2023-03-16 | 6/23 |

The bearing is installed so that it is insulated.
During operation, it is not permissible that the insulation is jumpered.

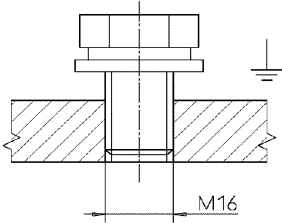
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|  | Document type Technical data for configuration | Created by GAE | | |
| | Title | Approved by PR | | |
| | Type : NDKK450-02-G Serial-No. : 11000101138-39 | Rev. | Date of issue 2022-04-07 | Sheet 7/23 |

3 Electrical connection

3.1 Machine grounding

Ground connection

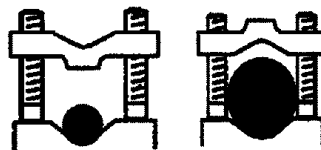
| | | |
|------------------------------|---------------------------------|---------------------|
| Dimension drawing position | ⊥ | |
| Conductor connection | Cable lug according to standard | |
| | DIN 46234 | DIN 46235 |
| Conductor cross-section max. | 240 mm ² | 400 mm ² |




3.2 Stator

Main terminal box

| | |
|----------------------------|---|
| Dimension drawing position | 1 |
| Material | Steel |
| Degree of protection | IP66 |
| Ground connection | 185 mm ² |
| Outer cable diameter | 35 ... 75 mm |
| Cable seal | Sealing ring that can be cut |
| Conductor connection | Terminal clamp |
| Conductor cross-section | Max. 50...300 / 120...400 mm ² |



| | | | | |
|---|----------------------------------|-------------|---------------|-------|
|  | Document type | Created by | | |
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3.3 Auxiliary circuits


Auxiliary terminal box

| | |
|----------------------------|---|
| Dimension drawing position | 3 |
| Material | Stainless steel 1.4301 |
| Degree of protection | IP66 |
| Conductor cross-section | Max. 4 mm ² |
| Connecting terminals | Intrinsically safe for circuits Ex i |
| Cable entry | Plate, removable, undrilled Customers are responsible for selecting the cable glands and machining the threaded bores. |

3.4 Anti-condensation heating

Auxiliary terminal box

| | |
|----------------------------|---|
| Dimension drawing position | 5 |
| Material | Stainless steel 1.4301 |
| Degree of protection | IP66 |
| Conductor cross-section | Max. 4 mm ² |
| Cable entry | Plate, removable, undrilled Customers are responsible for selecting the cable glands and machining the threaded bores. |

| | | | | |
|---|--|-------------------|-----------------------------|---------------|
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4 Auxiliary units

4.1 Heating

Anti-condensation heating electrical machine

| | |
|--|---------------|
| Voltage | 220 ... 240 V |
| Heating power | 364 ... 433 W |
| Ambient temperature ϑ_a | -5 ...+50°C |
| Surface temperature $\vartheta_{B \max}$ | 175 °C |



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5 Monitoring

5.1 Bearing temperature

Resistance thermometer

| | |
|--------------------|---------------------------|
| Type | 2 × Pt100 / B (IEC 60751) |
| Number at DE | 1 |
| Number at NDE | 1 |
| Type of protection | Ex eb |

5.2 Slot temperature

Resistance thermometer

| | |
|--------------------|---------------------------|
| Type | 1 × Pt100 / B (IEC 60751) |
| Number | 6 |
| Type of protection | Ex eb |

Assignment, thermometer to the monitored phase

| Phase | Connecting terminals |
|-------|----------------------|
| U | 20:1R1 |
| V | 20:2R1 |
| W | 20:3R1 |
| U | 20:4R1 |
| V | 20:5R1 |
| W | 20:6R1 |


Only temperature sensors integrated in the winding are suitable to monitor the winding temperature. Temperature sensors located at a different position supply incorrect values.

5.3 Measured value conversion

Measuring transducer

Number 5

Set the measuring transducer to the measuring range. Additional details are provided in the associated Operating and Maintenance Instructions.

| | | | | |
|---|--|-------------------|-----------------------------|----------------|
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6 Monitoring setpoints

6.1 Slot temperature

| | | |
|------------------------------------|----------|---|
| First setting before commissioning | Shutdown | $\vartheta_0 = 120\text{ °C}$ |
| Setting in operation | Alarm | $\vartheta_1 = \vartheta + 10\text{ K}$; max. 135 °C |
| | Shutdown | $\vartheta_2 = \vartheta + 15\text{ K}$; max. 140 °C |

ϑ = temperature in the steady-state condition / °C

6.2 Bearing temperature

| | | |
|------------------------------------|----------|--|
| First setting before commissioning | Shutdown | $\vartheta_0 = 95\text{ °C}$ |
| Setting in operation | Alarm | $\vartheta_1 = \vartheta + 2\text{ K}$; max. 97 °C |
| | Shutdown | $\vartheta_2 = \vartheta + 5\text{ K}$; max. 100 °C |

ϑ = temperature in the steady-state condition / °C


6.3 Bearing housing vibration

Comply with the specifications laid down in standard DIN ISO 10816-3.

Setting values according to DIN ISO 10816-3.

| Subassembly (foundation) | | Rigid | Flexible |
|------------------------------------|----------|------------------------|------------------------|
| First setting before commissioning | Alarm | 4.5 mm s ⁻¹ | 7.1 mm s ⁻¹ |
| | Shutdown | 7.1 mm s ⁻¹ | 11 mm s ⁻¹ |
| Setting in operation | Alarm | $v \times 1.25$ | $v \times 1.25$ |
| | Shutdown | 7.1 mm s ⁻¹ | 11 mm s ⁻¹ |

v = measured basis value of the vibration velocity

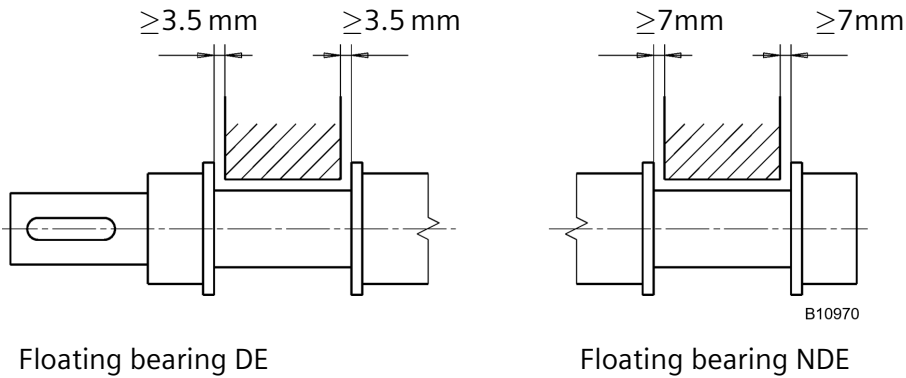
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| | Technical data for configuration | | GAE | |
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| | | PR | | |
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| | Serial-No. : 11000101138-39 | | 2022-04-07 | 12/23 |

7 Assembly

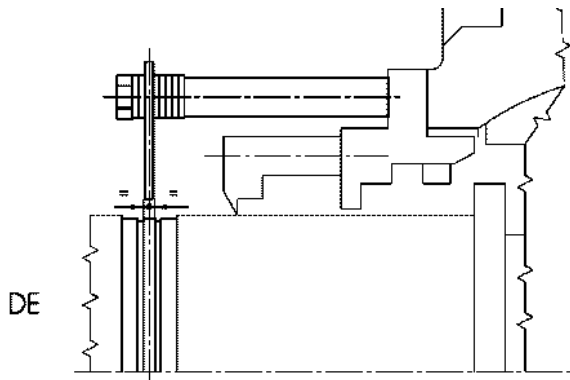
7.1 Axial bearing clearance

The bearings are floating bearings. The rotor must be axially guided using a locating bearing in the driven machine (driven load) or in the gearbox via the coupling.

Only use a coupling with fixed axial clearance. (± 0.5 mm up to ± 1.0 mm).



7.2 Pointer for the magnetic center of the axial rotor position



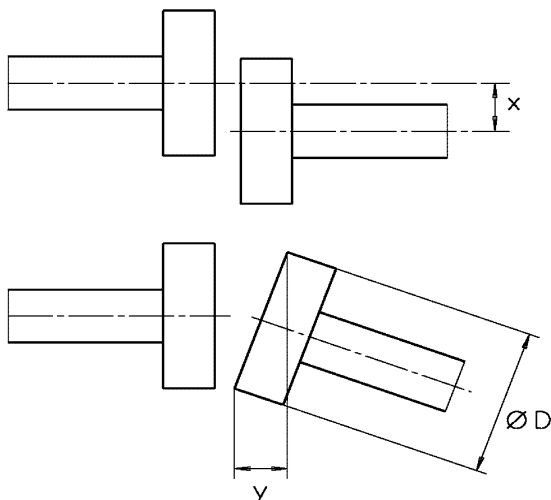
Before attaching the coupling, set the rotor to its magnetic center.

The axial bearing clearance has been correctly set if the pointer is located centered above the marking on the shaft. As a result of production tolerances, the bearing clearance can be somewhat higher than the specified values.

| | | | | |
|--|----------------------------------|-------------|---------------|-------|
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| | Title | Approved by | | |
| | | PR | | |
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| | Serial-No. : 11000101138-39 | | 2022-04-07 | 13/23 |

7.3 Alignment accuracy, coupling

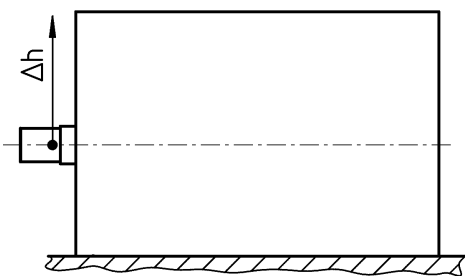
Also comply with the coupling manufacturer's instructions.



| | |
|-----|--|
| n | 0 ... 900 min ⁻¹ |
| x | Max. 0.09 mm |
| y | Max. 0.09 mm / 100 mm $\varnothing D$ |
| n | 900 ... 1800 min ⁻¹ |
| x | Max. 0.06 mm |
| y | Max. 0.05 mm / 100 mm $\varnothing D$ |
| n | 1800 ... 3600 min ⁻¹ |
| x | Max. 0.03 mm |
| y | Max. 0.025 mm / 100 mm $\varnothing D$ |

7.4 Thermal expansion

Shift of the non-coupled shaft end when operated with high thermal utilization levels:



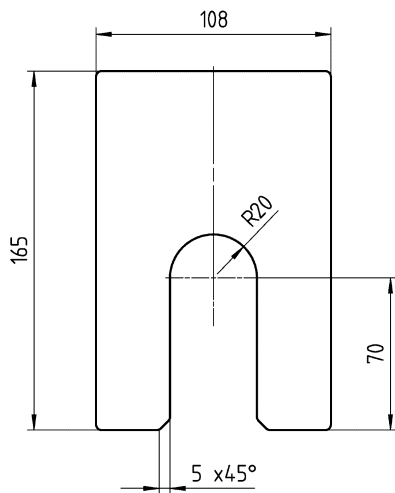
$$\Delta h = 0.17 \text{ mm}$$

To calculate the relative shifts of the machine referred to the environment, temperature expansion coefficient $\alpha = 12 \cdot 10^{-6} \text{ K}^{-1}$ applies.

| | | | | |
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7.5 Fastening

Shim geometry Material Steel / Brass



Mounting parts for fastening the machine onto a steel foundation.

(Not included in the scope of delivery)

Tightening torque for fastening screws $M_A = 1080 \text{ Nm} \pm 15 \%$

| Designation | Number | Standard | Specification |
|----------------|--------|----------|---------------|
| Mounting screw | 4 | ISO 4017 | M36×140 - 8.8 |
| Washer | 4 | ISO 7091 | 36 - 100HV |
| Jack screw | 4 | ISO 4017 | M24×100 - 8.8 |

7.6 Connection for purge air intake

Dimension drawing position 21

Air intake

Female thread $2 \times \text{Rp } 1/2'' + 1 \times \text{Rp } 1''$



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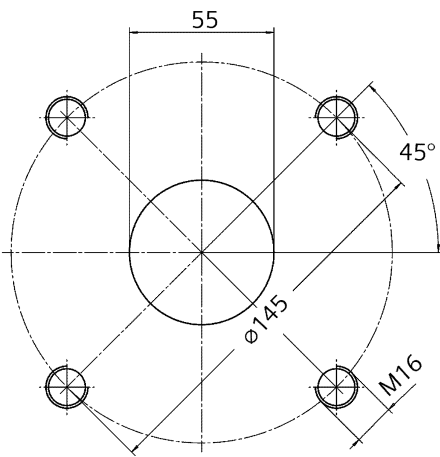
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7.7 Purge air outlet

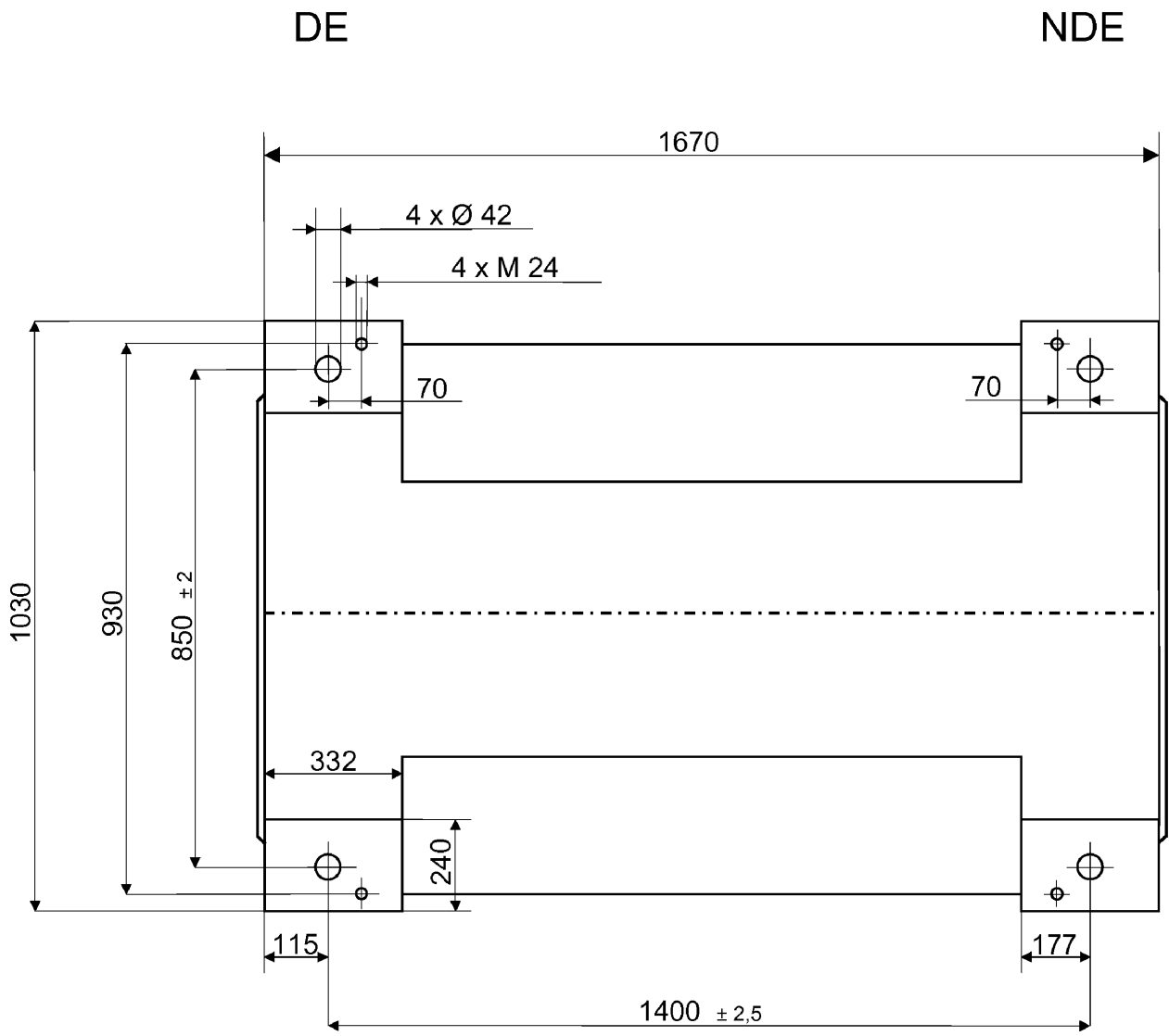
Dimension drawing position

22




| | | | | |
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8 Footprint drawing



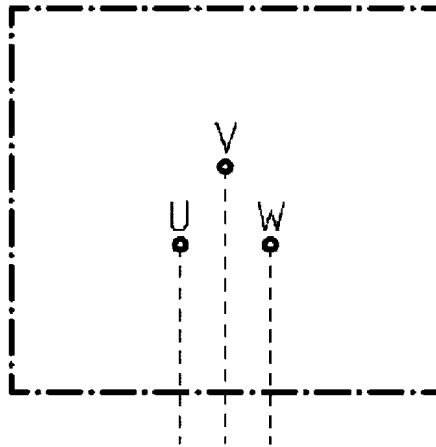
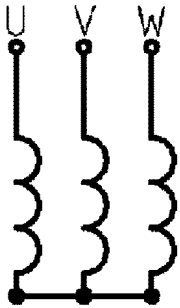
View from below

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9 Circuit diagrams/terminal diagrams

9.1 Circuit diagram Stator line connection

Dimension drawing position 1



 Schaltung
Connection

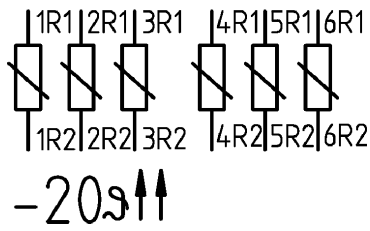
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9.2 Terminal diagram Auxiliary circuits

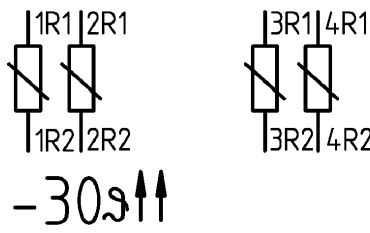
Dimension drawing position

3

| Terminal strip - X1 | | Link | Term.No. | Destination/ Item designation | |
|------------------------|---|------|----------|----------------------------------|---------|
| A | ○ | ● | PE | c | |
| B | ○ | ● | PE | c | |
| 4 | I | S | 8 | -20:1R1 | |
| 3 | | | 7 | | |
| 2 | | | 6 | | |
| 1 | | | 5 | -20:1R2 | |
| 4 | I | S | 8 | -20:2R1 | |
| 3 | | | 7 | | |
| 2 | | | 6 | | |
| 1 | | | 5 | -20:2R2 | |
| 4 | I | S | 8 | -20:3R1 | |
| 3 | | | 7 | | |
| 2 | | | 6 | | |
| 1 | | | 5 | -20:3R2 | |
| A | ○ | ● | 13 | c | -20:4R1 |
| B | ○ | ● | 14 | c | -20:4R2 |
| A | ○ | ● | 15 | c | -20:5R1 |
| A | ○ | ● | 16 | c | -20:5R2 |
| A | ○ | ● | 17 | c | -20:6R1 |
| A | ○ | ● | 18 | c | -20:6R2 |
| A | ○ | ● | 19 | c | |
| A | ○ | ● | 20 | c | |
| 4 | I | S | 8 | -30:1R1 | |
| 3 | | | 7 | | |
| 2 | | | 6 | | |
| 1 | | | 5 | -30:1R2 | |
| 4 | I | S | 8 | -30:3R1 | |
| 3 | | | 7 | | |
| 2 | | | 6 | | |
| 1 | | | 5 | -30:3R2 | |
| A | ○ | ● | 29 | c | -30:2R1 |
| A | ○ | ● | 30 | c | -30:2R2 |
| A | ○ | ● | 31 | c | -30:4R1 |
| A | ○ | ● | 32 | c | -30:4R2 |
| A | ○ | ● | 33 | c | |
| A | ○ | ● | 34 | c | |
| A | ○ | ● | 35 | c | |
| A | ○ | ● | PE | c | |



Slot thermometer
Nut-Thermometer



DE D-Seite NDE N-Seite

Bearing thermometer
Lager-Thermometer

Test voltage max. 5V for PTC or NTC thermistors,
thermo couples or resistance thermometers
Prüfspannung max. 5V bei Kalt-, Heißleitern,
Thermoelementen u. Widerstandsthermometern.

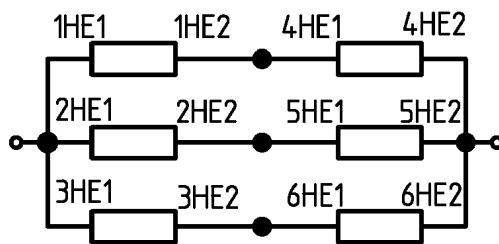
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9.3 Terminal diagram Anti-condensation heating

Dimension drawing position

5

| Terminal strip - X2 | | | Destination/ Item designation | |
|------------------------|------|----------|----------------------------------|---|
| | Link | Term.No. | A | B |
| ⌋ ● | ● | PE | A | B |
| ⌋ ● | ● | 1 | A | B |
| ⌋ ● | ● | 2 | A | B |
| ⌋ ● | ● | 3 | A | B |
| ⌋ ● | ● | 4 | A | B |
| ⌋ ● | ● | 5 | A | B |
| ⌋ ● | ● | 6 | A | B |
| ⌋ ● | ● | 7 | A | B |
| ⌋ ● | ● | 8 | A | B |



-80

Anti-condensation heater
Stillstandsheizung



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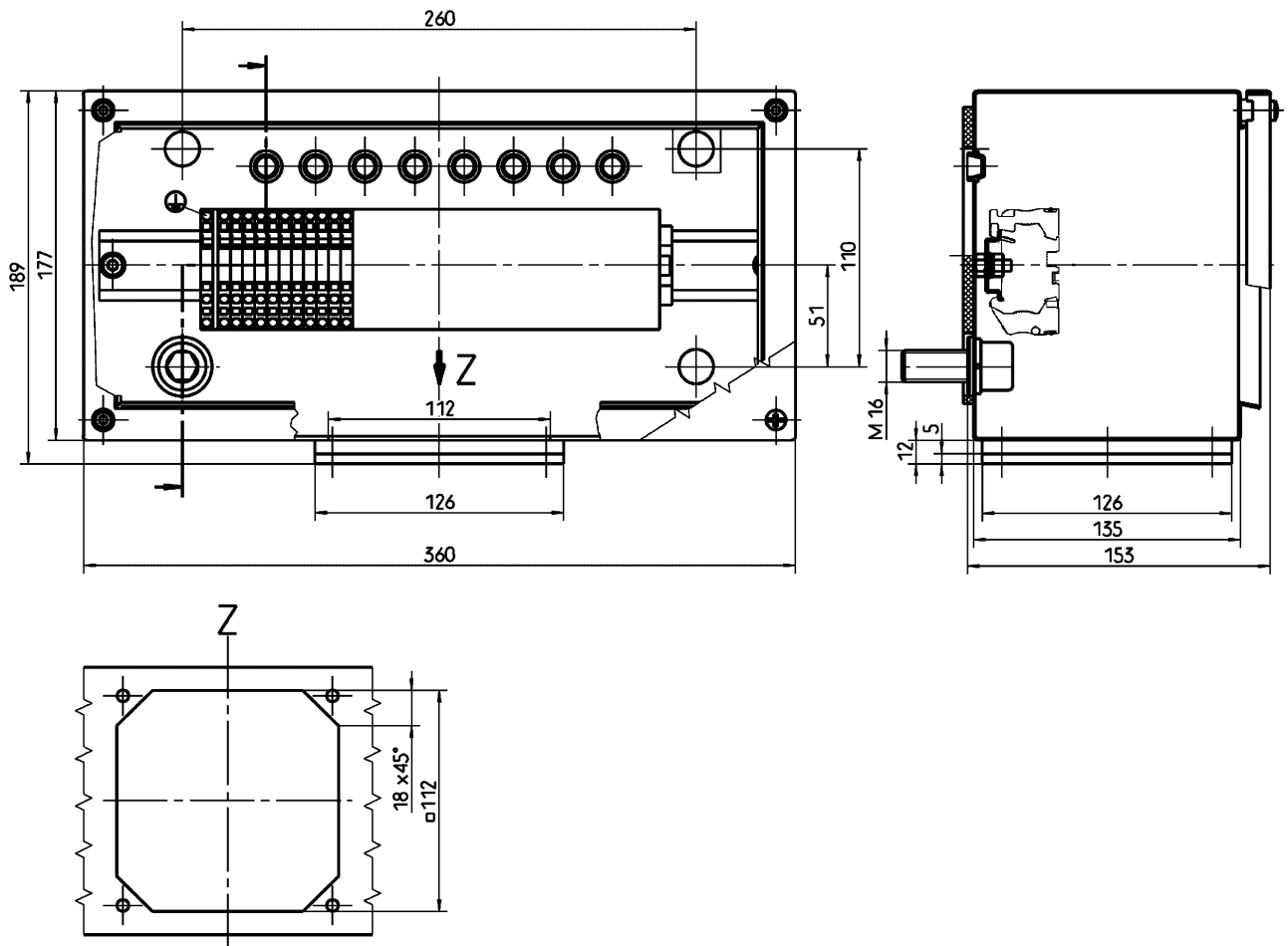
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10.2 Terminal box Auxiliary circuits

Dimension drawing position

3



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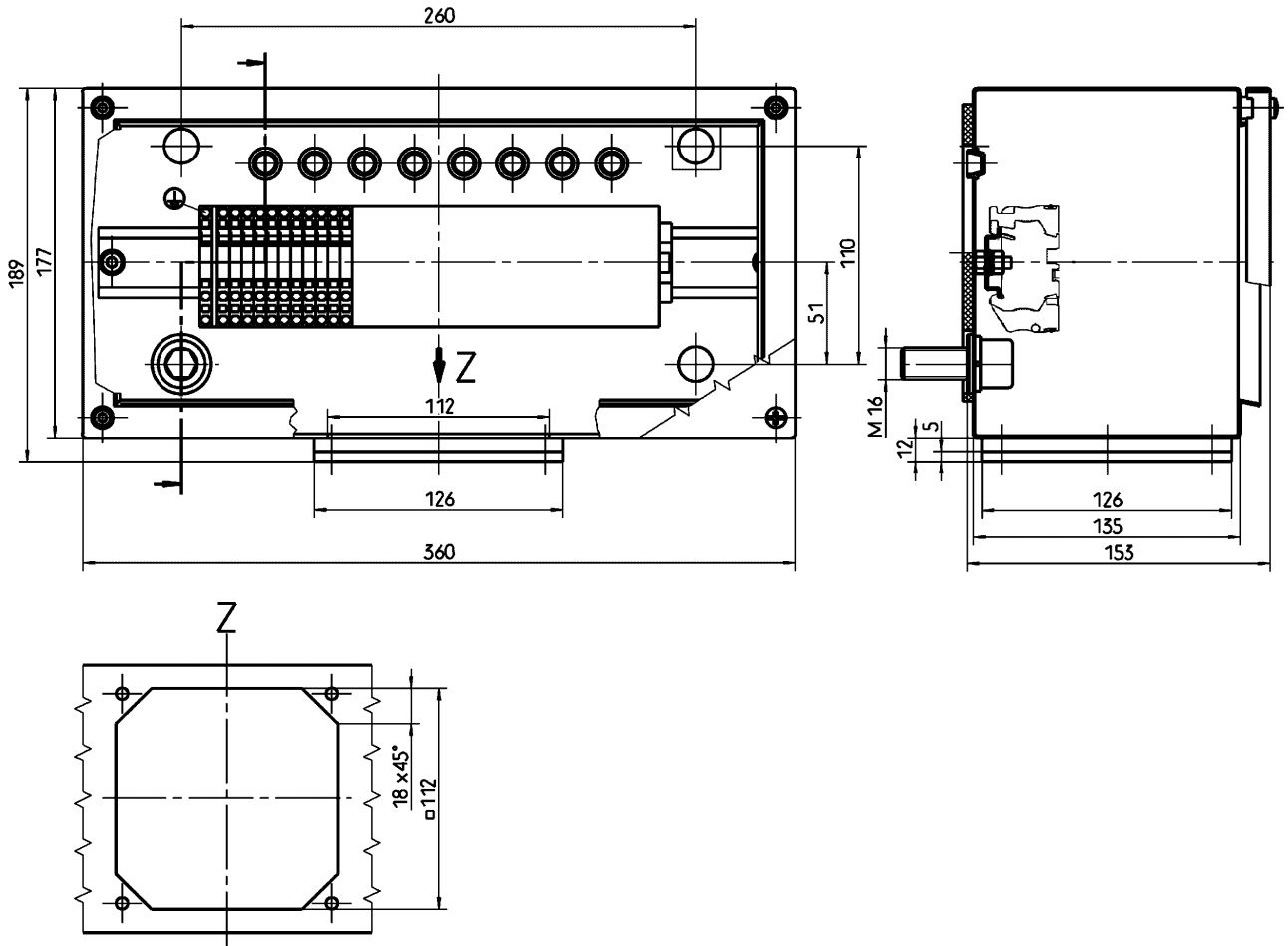
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10.3 Terminal box Anti-condensation heating

Dimension drawing position 5



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| | Serial-No. : 11000101138-39 | Rev. | Date of issue | Sheet |
| | | | 2022-04-07 | 23/23 |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7

Calculated Start-Up Data

| | | | | | |
|----------------------|-----------|------|------|--|--|
| Motor voltage | U/U_N | 1.00 | 0.80 | | |
| Locked-rotor torque | M_A/M_N | 0.60 | 0.37 | | |
| Pull-up torque | M_S/M_N | 0.59 | 0.37 | | |
| Breakdown torque | M_K/M_N | 2.50 | 1.58 | | |
| Locked-rotor current | I_A/I_N | 5.50 | 4.27 | | |

Calculated Partial Load Data


| | | | | | |
|---------------|------|------|------|------|--|
| P/P_N | 1.25 | 1.00 | 0.75 | 0.50 | |
| $\cos\varphi$ | 0.89 | 0.90 | 0.89 | 0.84 | |
| η [%] | 95.7 | 96.1 | 96.3 | 95.8 | |

Additional Technical Ratings and Information

Rotor material: E-CU

Measuring surface sound pressure level (no-load): 78 dB(A), tol.: 3 dB(A)

The mains voltage may vary by up to +-5% and the mains frequency by up to +-2% from the rated values, in keeping with zone A according to IEC 60034-1

| | | | | |
|---|----------------------------|-------------|---------------|-------|
|  | Document type | Created | | |
| | Electrical Data Sheet | Gae | | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G | Pr | | |
| | Order No. : 11000101138-39 | Rev. | Date of issue | Sheet |
| | | | 2022-03-21 | 1/7 |

Three-Phase-Induction Motor with Squirrel Cage Rotor

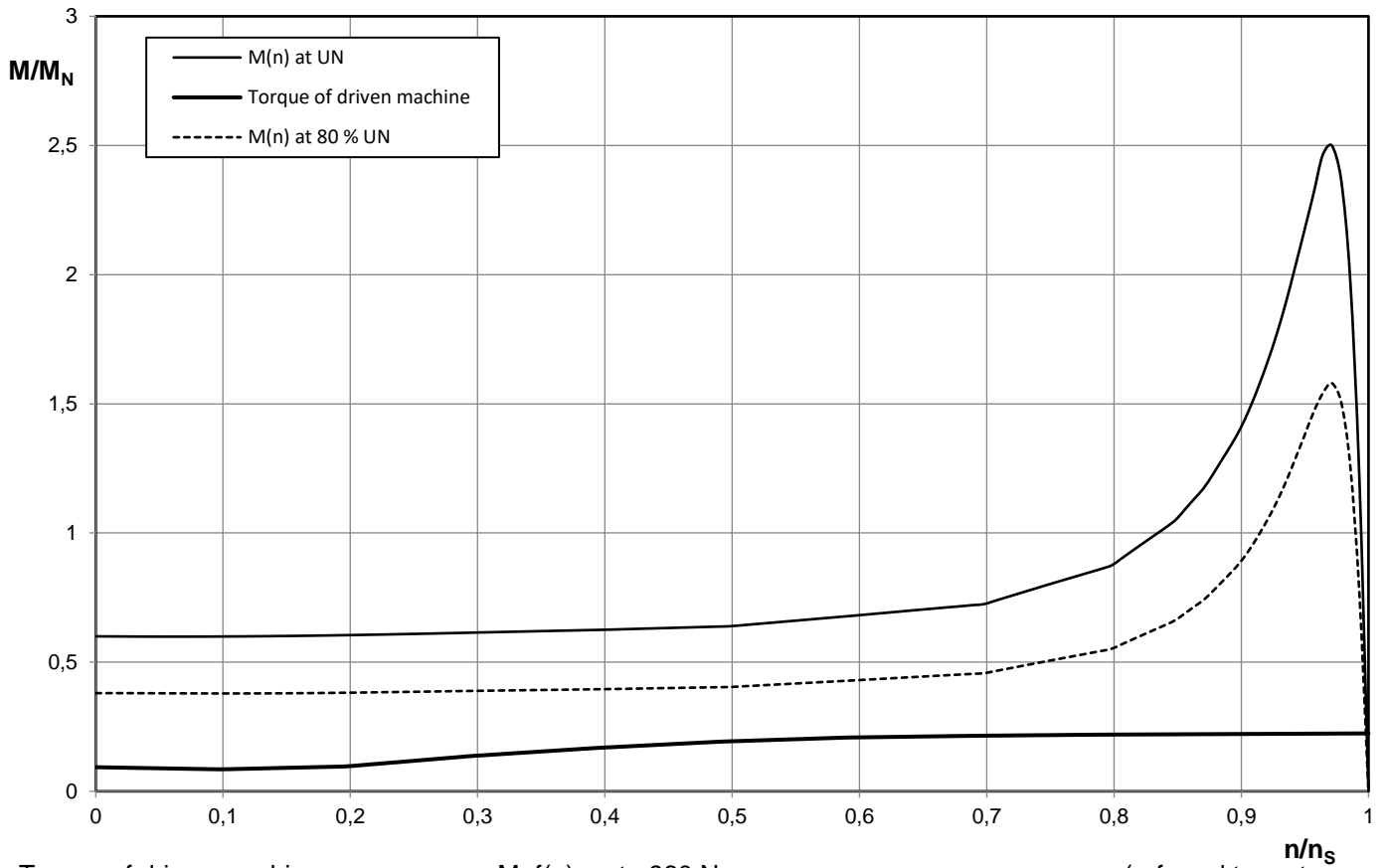
Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7



| | | |
|--------------------------|-----------------------|---------------------------|
| Torque of driven machine | $M=f(n)$ up to 960 Nm | (referred to motor speed) |
| Driven machine | Srew compressor | |
| Required power | | |
| Moment of inertia (load) | 3.1 kgm ² | (referred to motor speed) |
| Starting time | 3 s | at $U/U_N = 1.00$ |
| | 6 s | at $U/U_N = 0.80$ |
| Perm. number of starts | 3 cold, 2 warm | at $U/U_N = 1.00$ |
| | 3 cold, 2 warm | at $U/U_N = 0.80$ |
| | | 1000 per year |



Document type

Starting Data $M=f(n)$

Title

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Order No. : 11000101138-39

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Three-Phase-Induction Motor with Squirrel Cage Rotor

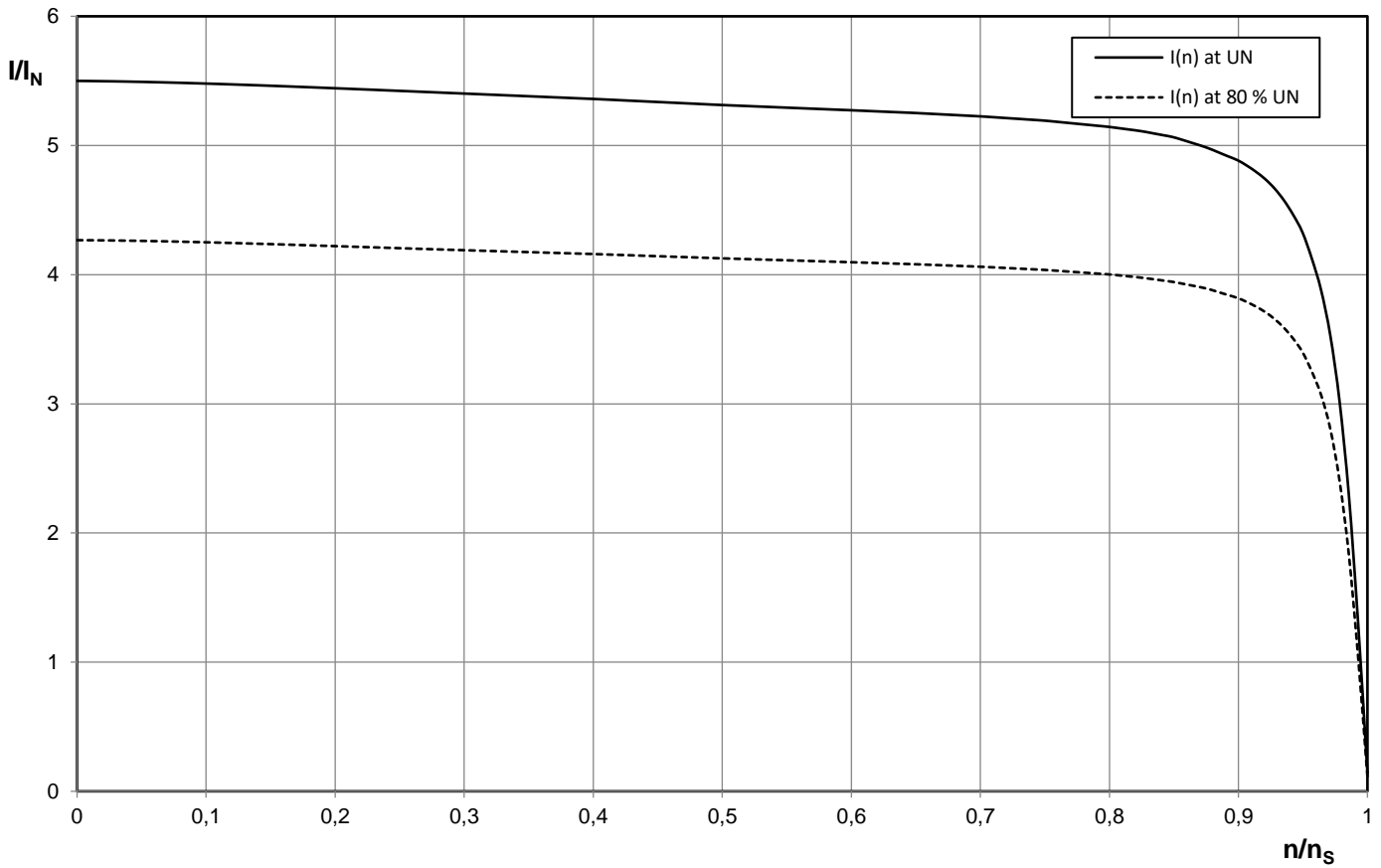
Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7



| | | | | |
|--|----------------------------|-------------|---------------|-------|
| | Document type | Created | | |
| | Starting Data I=f(n) | Gae | | |
| | Title | Approved by | | |
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| | Order No. : 11000101138-39 | Rev. | Date of issue | Sheet |
| | | | 2022-03-21 | 3/7 |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

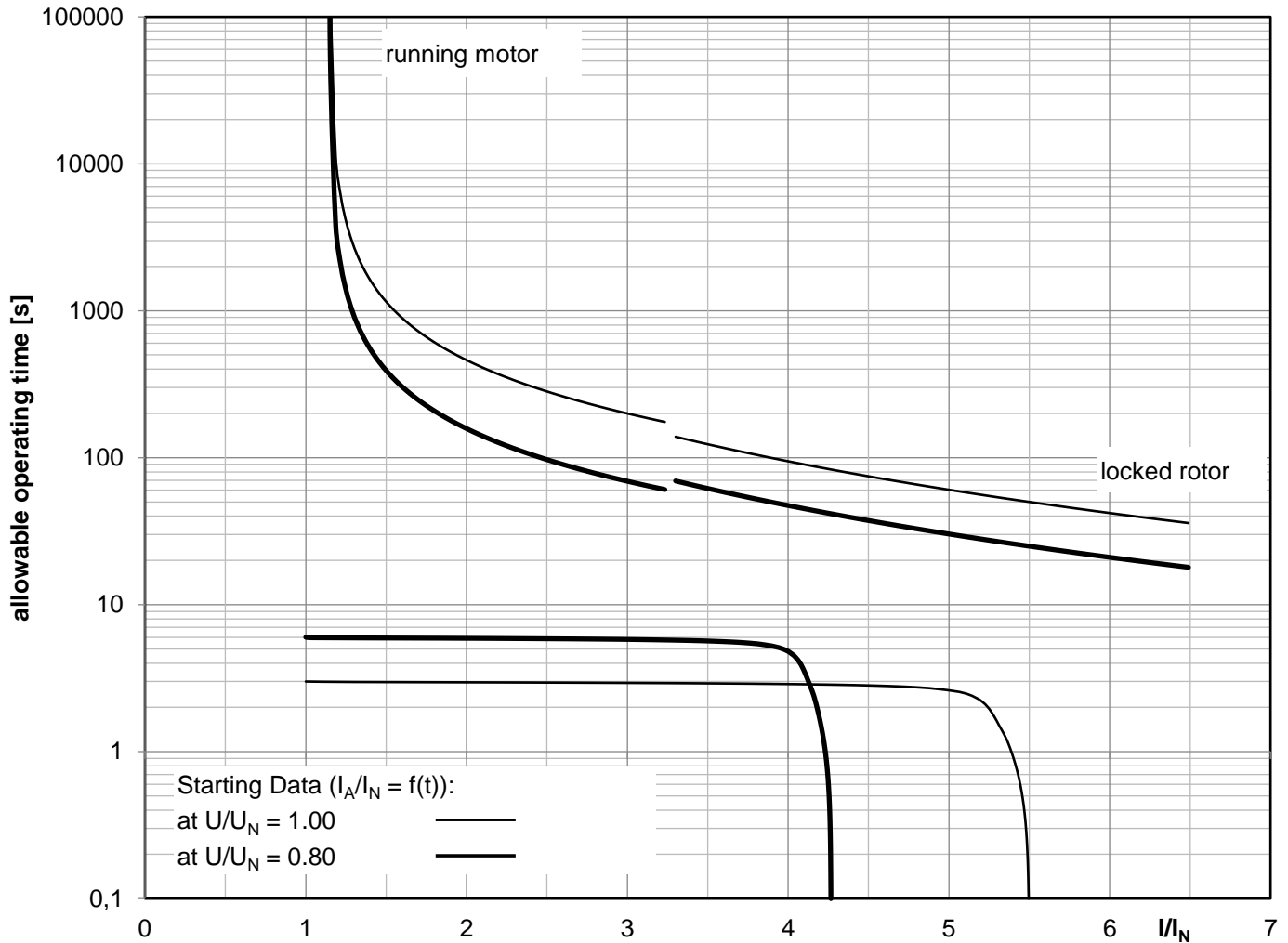
Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7

— for cold motor condition

— for warm motor condition



| | |
|--|---------|
| Thermal copper time constant (short-term load variation) | 12 min |
| Thermal time constant (long-term load variation) | 25 min |
| Thermal time constant for cooling down (standstill) | 176 min |

| | | | | |
|--|----------------------------|-------------|---------------|-------|
| | Document type | Created | | |
| | Thermal Limit Curve | | Gae | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G | Pr | | |
| | Order No. : 11000101138-39 | Rev. | Date of issue | Sheet |
| | | | 2022-03-21 | 4/7 |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated- | | | | |
| -power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7

| |
|---|
| $\text{Trans. Torque in Air Gap: } M(t)/M_N = \Sigma (M/M_N \times e^{(t^{\tau})} \times \sin(2\pi \times f \times t + \varphi))$ |
|---|

Starting with locked rotor and $U_{Line} = 100\%$

| M/M_N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|---------|---------------|-------|------------------|
| 0.51 | 0.00 | 0.00 | 90.00 |
| 0.51 | -39.35 | 0.00 | 90.00 |
| 4.14 | -0.26 | 50.00 | -172.95 |
| 4.14 | -39.09 | 50.00 | -7.05 |

$$M_{max}/M_N = 4.48 \text{ at } t = 134.6\text{ms}$$

3-pole terminal short circuit

| M/M_N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|---------|---------------|-------|------------------|
| -0.53 | -24.17 | 0.00 | 90.00 |
| -0.22 | -54.53 | 0.00 | 90.00 |
| 5.98 | -39.35 | 48.90 | 162.89 |


$$M_{max}/M_N = 5.37 \text{ at } t = 5.6\text{ms}$$

2-pole terminal short circuit

| M/M_N | τ/s^{-1} | f/Hz | $\varphi/degree$ |
|---------|---------------|--------|------------------|
| 0.19 | 0.00 | 0.00 | 90.00 |
| -0.53 | -24.17 | 0.00 | 90.00 |
| -0.06 | -54.53 | 0.00 | 90.00 |
| 2.87 | -12.09 | 49.84 | 175.15 |
| 1.48 | -27.27 | 0.93 | 15.36 |
| 3.00 | -39.35 | 48.90 | 162.64 |
| 1.44 | 0.00 | 100.00 | -5.24 |
| 0.39 | -12.09 | 50.16 | 91.15 |
| 1.49 | -27.27 | 99.07 | -15.16 |

$$M_{max}/M_N = 6.93 \text{ at } t = 7\text{ms}$$

The value of the mechanical torque of the whole shafting can only be determined by using the above transient torques in a torsional analysis calculation. The plant manufacturer is responsible for the torsional vibrations analysis.

| | | | | | | |
|---|---------------|-------------------|--|-------------|---------------|-------|
|  | Document type | Transient Torques | | Created | Gae | |
| | Title | | | Approved by | Pr | |
| | Type : | NDKK450-02-G | | Rev. | Date of issue | Sheet |
| | Order No. : | 11000101138-39 | | | 2022-03-21 | 5/7 |

Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7

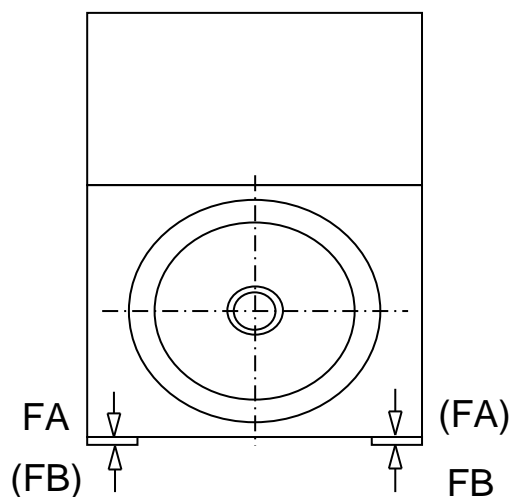
Foundation Load

The listed foundation loads are derived from a stress analysis for a rigid foundation, caused by the maximum dynamic torque and the machine weight. The forces occur alternately on each side of the machine, irrespective of the direction of rotation.

Transfer of vibrations from the surrounding has to be avoided by appropriate layout of foundation. On the basis of DIN 4024 Part 1 the natural frequencies f_n of the system - machine on foundation - must differ as follows from the operating frequencies f_m (for mains-fed operation: Rotating frequency, double rotating frequency, line frequency and double line frequency, for converter-fed operation: Rotating frequency, double rotating frequency, supply frequency and double supply frequency):

- 1. Natural frequency of system: $f_1 \geq 1.25 f_m$ or $f_1 \leq 0.8 f_m$
- Higher natural frequencies: $f_n \geq 1.1 f_m$ or $f_n \leq 0.9 f_m$

→ The plant manufacturer is responsible for the design of the foundations!



2-pole terminal short circuit

compressive force $FA = 60 \text{ kN}$
tensile force $FB = 8 \text{ kN}$

(forces on one side of the machine)

| | | | | |
|--|----------------------------|-------------|---------------|-------|
| | Document type | Created | | |
| | Foundation Load | Gae | | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G | Pr | | |
| | Order No. : 11000101138-39 | Rev. | Date of issue | Sheet |
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Three-Phase-Induction Motor with Squirrel Cage Rotor

Operating and Installation Data

| | | | | |
|--------------|---------------|------------|-----------------------------|-------------------|
| Rated-power | P_N | 1340 kW | Connection | Y |
| -voltage | U_N | 6000 V | Class of rating | S1 |
| -frequency | f_N | 50 Hz | Absolute altitude | <1000 m ab.s.l. |
| -current | I_N | 150 A | Coolant temperature | 50 °C |
| -speed | n_N | 2984 1/min | Therm. class (design/util.) | 155 (F) / 130 (B) |
| -torque | M_N | 4289 Nm | | |
| Power factor | $\cos\varphi$ | 0.9 | | |

Standard: IEC/EN 60034-1

Tolerances: IEC/EN 60034-1

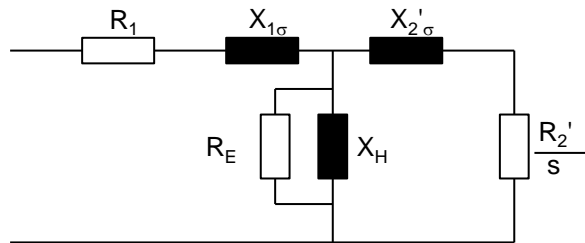
Type of ignition protection: Ex ec IIC T3 Gc, IEC/EN 60079-0,-7

Resistances, Reactances (Calculated Values per Phase)

| | | | |
|---------------------------------|-------------------------|--------------|---------------|
| Values (p.u.) referred to Z_N | $Z_N = U_{PH} / I_{PH}$ | | 23.1 Ω |
| at slip | | $s = 0.0053$ | $s = 1$ |
| Stator-resistance | R_1 / Z_N | 0.00713 | 0.00713 |
| Stator-leakage reactance | $X_{1\sigma} / Z_N$ | 0.20684 | 0.12954 |
| Rotor-resistance | R_2' / Z_N | 0.00529 | 0.01613 |
| Rotor-leakage reactance | $X_{2\sigma}' / Z_N$ | 0.07390 | 0.05946 |
| Magnetizing-reactance | X_H / Z_N | 5.688 | 5.956 |
| Ironloss-resistance | R_E / Z_N | 186.40 | 186.40 |

The resistances apply to the warm machine.

The rotor-resistances / -reactances refer to the stator.



Document type

Equivalent-Circuit Diagram

Title

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1 Description


Anti-condensation heating can be provided for motors when there is a danger that condensation will form on the winding due to the climatic conditions. The anti-condensation heater warms up the air in the motor to a temperature that is 6 to 7 K higher than the external temperature in order to prevent condensation forming inside the motor. Therefore, the motor is always ready for use.

Anti-condensation heaters with "increased safety" (Ex eb) are installed in electric machines to be used in hazardous zones.

Note: If the anti-condensation heating is operated with the machine running, this can result in increased temperatures in the machine. Therefore, use an interlocking circuit that switches off the anti-condensation heating when the machine is switched on.

2 Technical data

| | |
|------------------------|--|
| Version: | Ex eb |
| Temperature class: | T3 (max. surface temperature: 200 °C) |
| Operating temperature: | -40 °C ≤ Ta ≤ +60 °C |
| Heating element: | Tubular heater 8V-XXX-YYY-230V-ZZZ-H95396000 |
| | 8 Outer tube diameter |
| | V CrNi steel |
| | XXX Total tube length in centimeters |
| | YYY Length of the unheated tube end in centimeters |
| | 230V Rated voltage |
| | ZZZ Rated power in watts |
| | H95396000 M4 screw connection, ceramic nipple sealed with casting compound |
| Rated voltage: | 220 to 240 V |
| Permissible voltage: | 198 to 264 V |


| | | | | |
|---|-----------------------------|-------------|---------------|-------|
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| | | | |
|---------------------|-----------------------------------|--------------------------------|--------------|
| Rated power: | ...DOR... : | Shaft heights 310 L up to 560: | 174 to 207 W |
| | | Shaft height 310 M: | 119 to 142 W |
| | | Shaft height 630: | 366 to 436 W |
| | ...DKK... : | Shaft height 450: | 364 to 433 W |
| | | Shaft height 500: | 412 to 490 W |
| | | Shaft heights 560 and 630: | 480 to 572 W |
| Required terminals: | 4 for ...DOR... ; 7 for ...DKK... | | |

3 Principle of operation

The anti-condensation heating is a tubular heater. The jacket, manufactured out of chrome nickel steel (non-rusting), has a spiral heating wire running through its center, which is electrically decoupled from the tube jacket using a thermally conductive isolator (MgO).

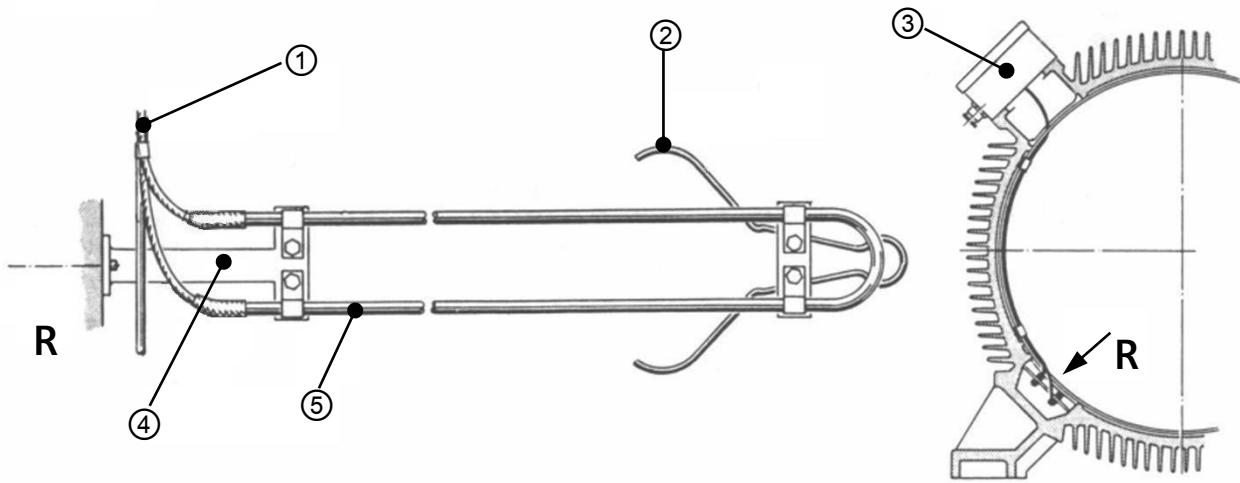
When electric current flows through the heating wire, heat will be generated through the electrical resistance and transferred to the tube sheath.

| | | | | |
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4 Installation

Figure 1: ...DOR...

Note: The positioning and cable routing of the ...DOR... series with shaft height 630 is identical to that of ...DKK... machines.



- | | |
|-----------------------|-----------------------------|
| (1) Connection cables | (4) Heater support |
| (2) Tension spring | (5) Tubular heating element |



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Figure 2: ...DKK...

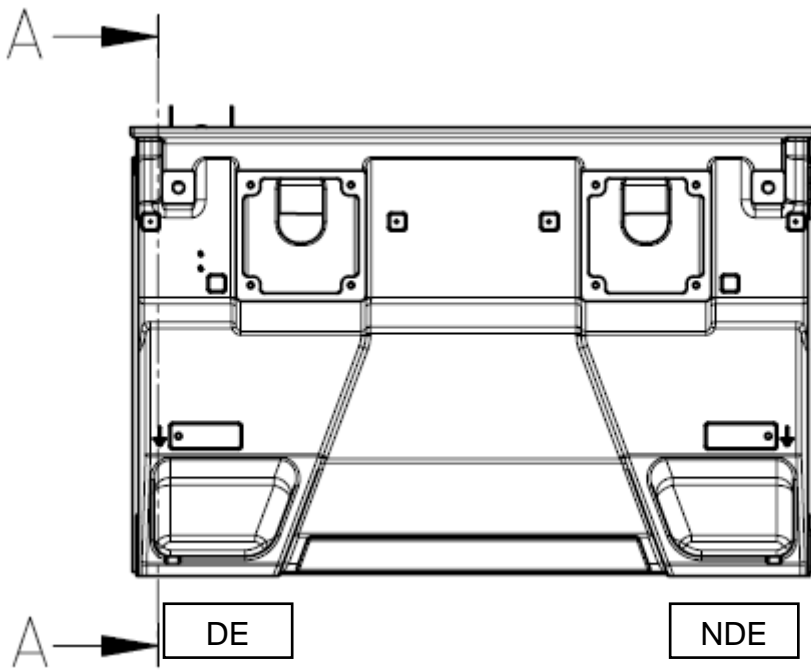
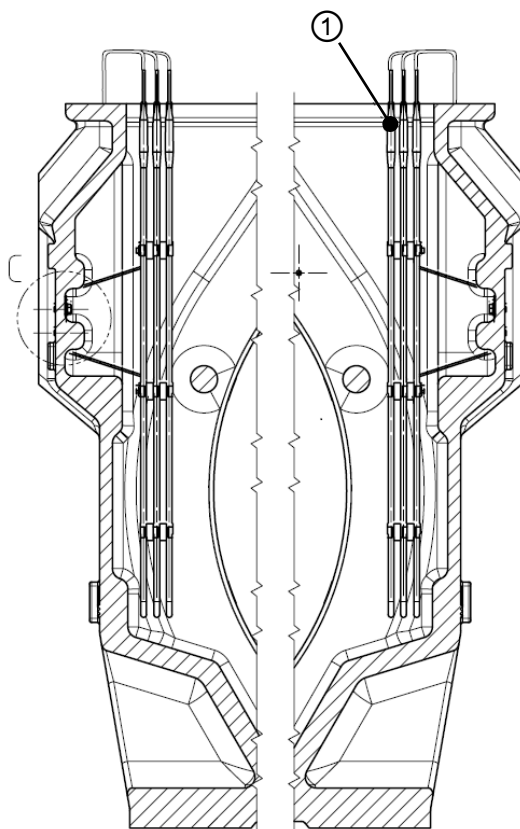


Figure 3: Section A-A




| | | | | |
|---|---|--------------------------|-----------------------------|----------------|
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| | Title Type : NDKK450-02-G Serial-No. : 11000101138-39 | Approved by PR | | |
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Figure 4: Section B-B

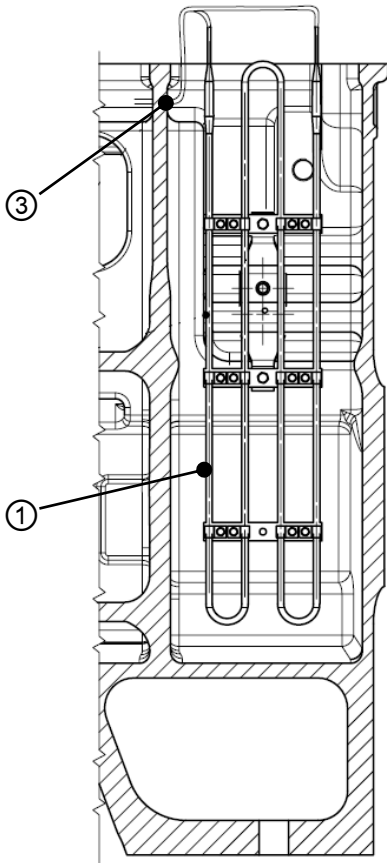
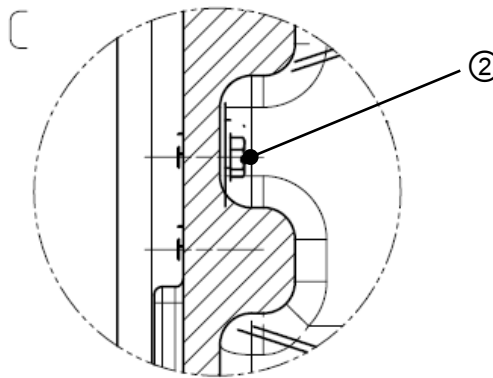



Figure 5: Section C-C



- (1) Tubular heating element
- (2) Attachment bolt
- (3) Connecting cable

DE Drive end

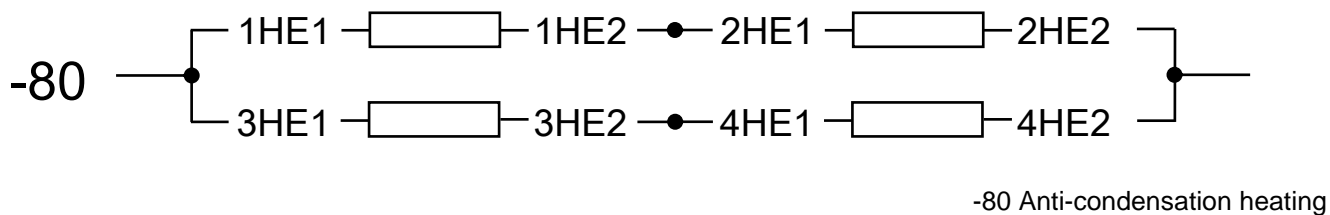
NDE Non-Drive End

| | | | | |
|---|-----------------------------|-------------|---------------|-------|
|  | Document type | Created by | | |
| | Instrument data sheet | | GAE | |
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| | Serial-No. : 11000101138-39 | Rev. | Date of issue | Sheet |
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5 Electrical connection

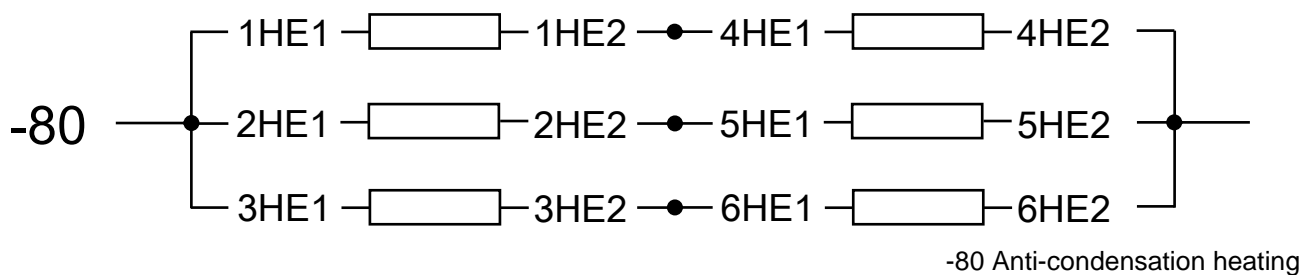
Block diagram of the heating elements

Figure 6: ...DOR...



Note: Connection in the auxiliary terminal box

Figure 7: ...DKK...



Note: Connection in the auxiliary terminal box



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Instrument data sheet

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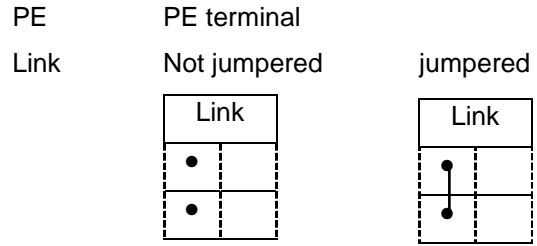
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Terminal strip

Figure 8: Example of a terminal strip assignment
(...DOR...)

| Terminal strip - X2 | | | Destination / Item designation | |
|------------------------|------|----------|-----------------------------------|----------|
| | Link | Term.No. | | |
| C ○ | • | PE | A | |
| | | | B | |
| C ○ | • | 1 | A | -80:1HE1 |
| | | | B | -80:3HE1 |
| C ○ | • | 2 | A | -80:1HE2 |
| | | | B | -80:2HE1 |
| C ○ | • | 3 | A | -80:3HE2 |
| | | | B | -80:4HE1 |
| C ○ | • | 4 | A | -80:2HE2 |
| | | | B | -80:4HE2 |
| C ○ | • | PE | A | |
| | | | B | |



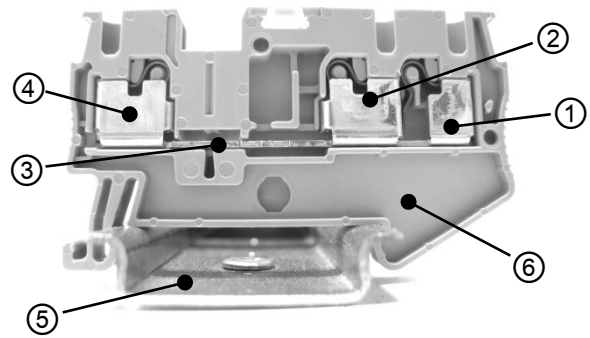
-80:1HE2 (-80) anti-condensation heating,
(:) separator, (1HE) 1. heating resistor,
(2) 2. connection

Figure 9:

Example of a terminal strip assignment
(...DKK...)

| Terminal strip - X2 | | | Destination / Item designation | |
|------------------------|------|----------|-----------------------------------|----------|
| | Link | Term.No. | | |
| C ○ | • • | PE | A | |
| | | | B | |
| C ○ | • • | 1 | A | -80:1HE1 |
| | | | B | -80:2HE1 |
| C ○ | • • | 2 | A | -80:3HE1 |
| | | | B | |
| C ○ | • • | 3 | A | -80:4HE2 |
| | | | B | -80:5HE2 |
| C ○ | • • | 4 | A | -80:6HE2 |
| | | | B | |
| C ○ | • • | 5 | A | -80:1HE2 |
| | | | B | -80:4HE1 |
| C ○ | • • | 6 | A | -80:2HE2 |
| | | | B | -80:5HE1 |
| C ○ | • • | 7 | A | -80:3HE2 |
| | | | B | -80:6HE1 |
| C ○ | • • | PE | A | |
| | | | B | |

Figure 10: Terminal strip with rail (profile element)



- (1) Input (A)
- (2) Input (B)
- (3) Busbar
- (4) Output (C): Heating connection
- (5) Rail (steel, zinc-plated)
- (6) Housing (plastic)

Terminals A, B and C have the same potential.

| | | | | |
|--|-----------------------------|-------------|---------------|-------|
| | Document type | Created by | | |
| | Instrument data sheet | GAE | | |
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2 double resistance thermometers PT100 for sleeve bearing

1 Description

When the particular temperature limits are exceeded, bearing lubricants can lose their lubricating properties, which can result in the bearings being damaged. To avoid this, bearing temperatures should be permanently monitored using resistance thermometers (PT100).


Encapsulated PT100 (Ex eb or mb) resistance thermometers are used for electrical machines where protection against ignition is required.

2 Technical data

| | |
|-----------------------|--|
| Implementation: | Normal, Ex eb and mb |
| Manufacturer: | Ephy-Mess GmbH, Wiesbaden-Delkenheim, Germany, Ex eb Heinz Messtechnik GmbH, Elgersburg (Thuringia), Germany, Ex mb |
| Type: | Resistance thermometers 2 x PT 100 / e x 6 / M10x1 1x: Double element per bearing PT100: Sensor material: Platinum (100 Ω at 0 °C) e x 6: Nominal length (e) x diameter (6mm) For e: 150, 200 or 250 mm; depends on the motor type M10x1: Screw connection |
| Measuring range: | Standard -40 to + 150 °C Ex: -40 to + 125 °C |
| Degree of protection: | Standard: IP 55 Ex: IP 66 |
| Connection: | Two wires from the element up to the terminal box Two, three or four-wire circuit from the terminal box |
| Required terminals: | 8 |
| Input signal: | Rated current depending on the measuring resistance max. 5 mA (DC or AC current) |
| Output signal | Rated voltage max. 6 V (voltage change) |

If required, a **calibration certificate** can be ordered at the same time.

Evaluation units are not included in the scope of delivery.

| | | | |
|---|---|-------------------|-----------------------------|
|  | Document type Instrumentation data sheet | Created Gae | |
| | Title | Approved by Pr | |
| | Type : NDKK450-02-G Order No. : 11000101138-39 | Rev. | Date of issue 2019-09 23 |
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3 Principle of operation

The temperature sensor in the resistance thermometer is a platinum measuring resistor, the resistance of which changes with the temperature according to a series of specific, reproducible basic value series. Since the current through the sensor is constant, the resistance change is proportional to the voltage change. You can determine the temperature change from the voltage change. At 0 °C, the measuring resistor is calibrated for 100 Ω ± 0.1 Ω. The basic values of the resistors (the relationship between the resistance and temperature) as well as the permissible deviations are defined in IEC 60751.

Characteristic values for the platinum measuring sensor (PT100):

Table 1: Basic value series (IEC 60751)

| °C | Ω | °C | Ω |
|-----|--------|-----|--------|
| -50 | 80,31 | 80 | 130,90 |
| -40 | 84,27 | 90 | 134,71 |
| -30 | 88,22 | 100 | 138,51 |
| -20 | 92,16 | 110 | 142,29 |
| -10 | 96,09 | 120 | 146,07 |
| 0 | 100,00 | 130 | 149,83 |
| 10 | 103,90 | 140 | 153,58 |
| 20 | 107,79 | 150 | 157,33 |
| 30 | 111,67 | 160 | 161,05 |
| 40 | 115,54 | 170 | 164,77 |
| 50 | 119,40 | 180 | 168,48 |
| 60 | 123,24 | 190 | 172,17 |
| 70 | 127,08 | 200 | 175,86 |

Notice: The resistance thermometer should only be checked with a single-dial measuring bridge in "Wheatstone connection"!

Table 2: Deviation limit (IEC 60751)

| Class | Deviation in °C |
|------------------|--------------------------|
| A (*) | $0,15 + 0,002 \cdot t $ |
| B (*) [standard] | $0,30 + 0,005 \cdot t $ |

| t | is the numerical value of the temperature in °C, without taking the sign into account

(*) only valid for three or four wire circuits

Figure 1: Deviation limit (IEC 60751) Class B, standard:

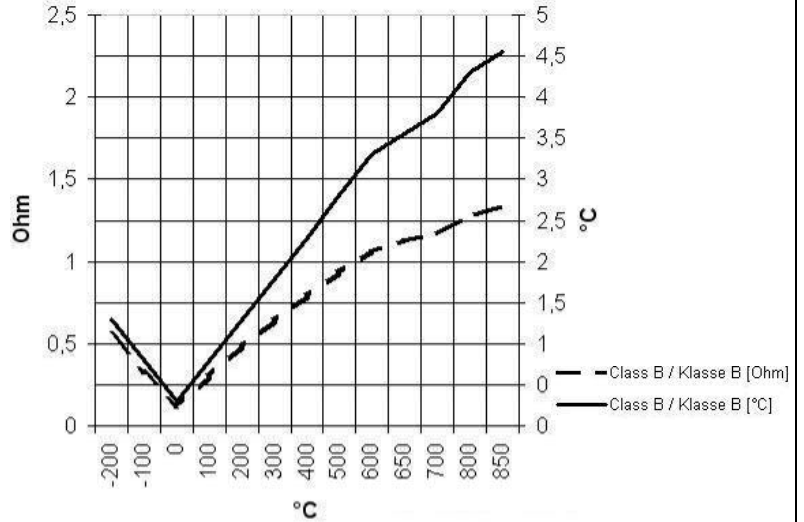
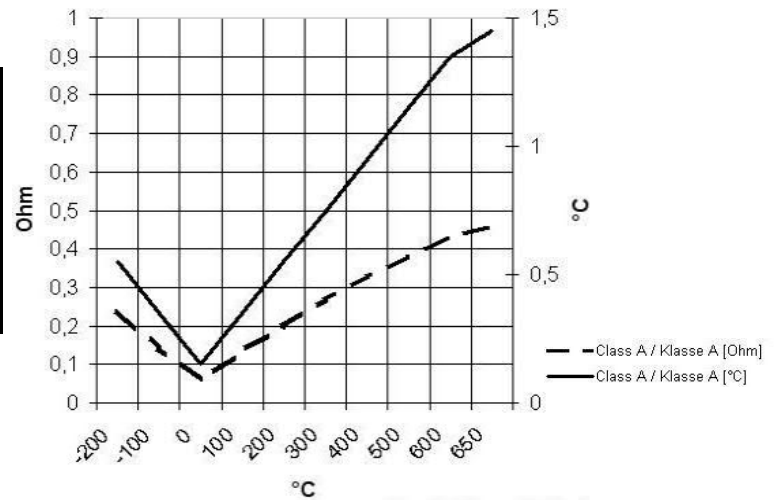


Figure 2: Deviation limit (IEC 60751) Class A:



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4 Installation

Installation and cable routing for high voltage motors

Figure 3: Installation and cable routing for ...DKK...

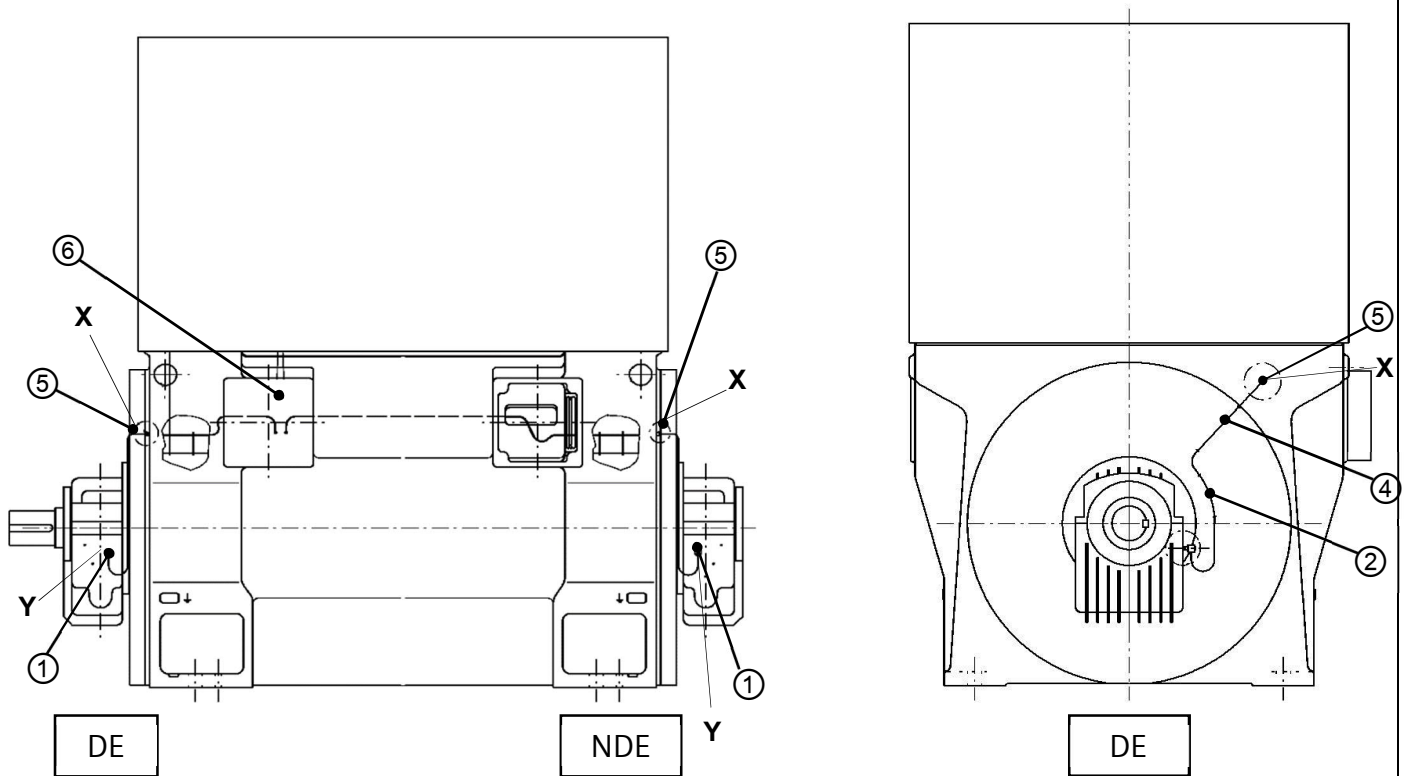
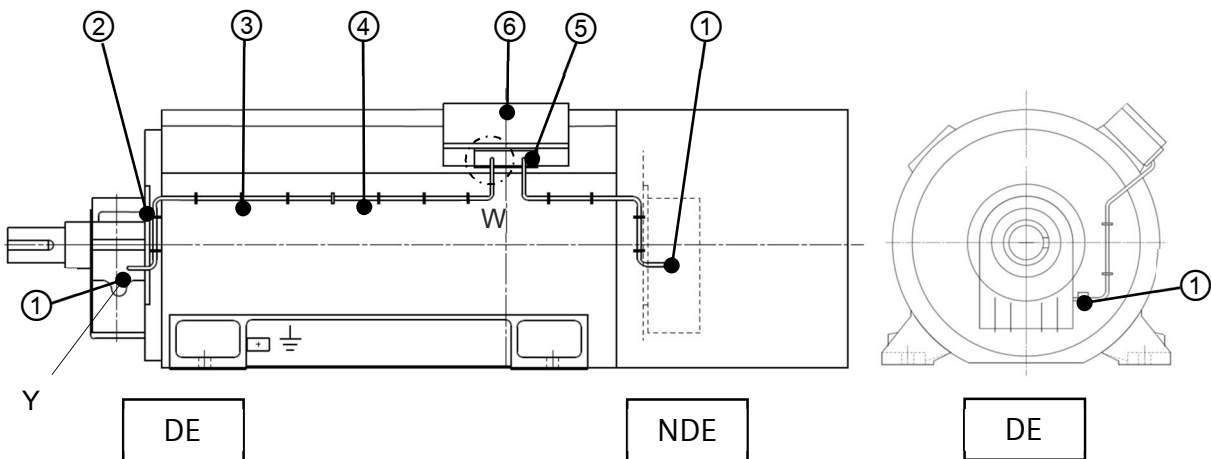


Figure 4: Installation and cable routing for ...DOR...




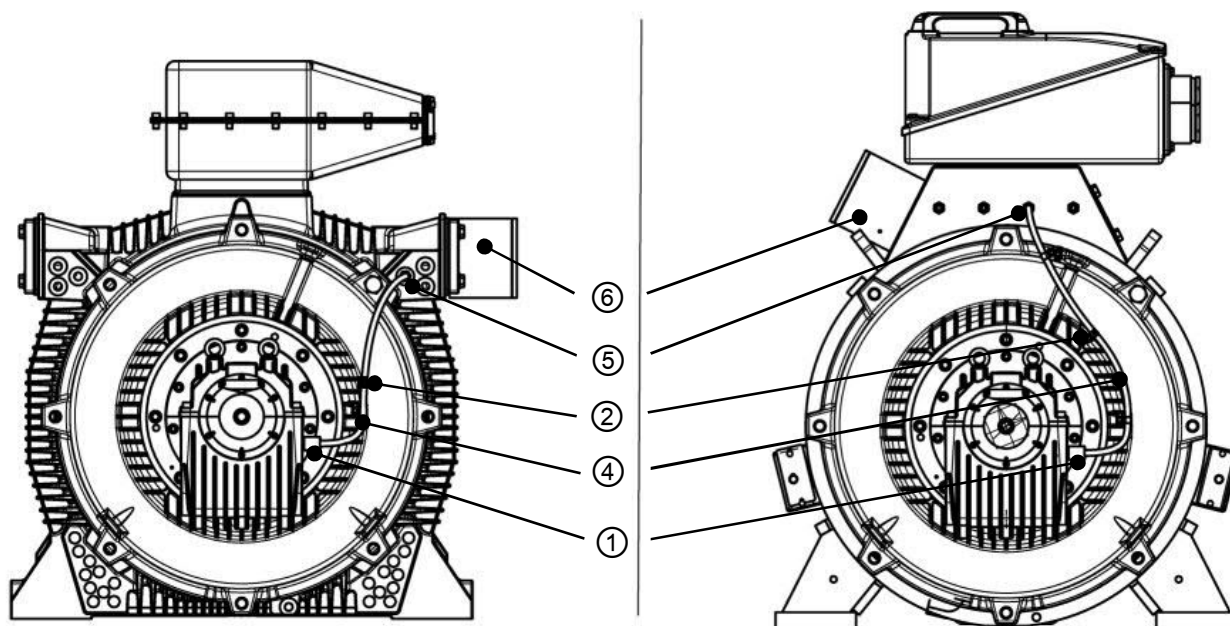
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|  | Document type Instrumentation data sheet | Created Gae | | |
| | Title | Approved by | | |
| | Type : NDKK450-02-G Order No. : 11000101138-39 | Rev. | Date of issue 2019-09 23 | Sheet 3 / 7 |

Figure 5: Installation and cable routing for ...DOR... / ...DWR..., seen from DE (left: Air-cooled, right: Water-cooled)



- (1) Bearing thermometer
- (2) Clamp
- (3) Wiring clip
- (4) Protective tube

- (5) Cable gland
- (6) Auxiliary terminal box
- DE Drive End
- NDE Non-Drive End



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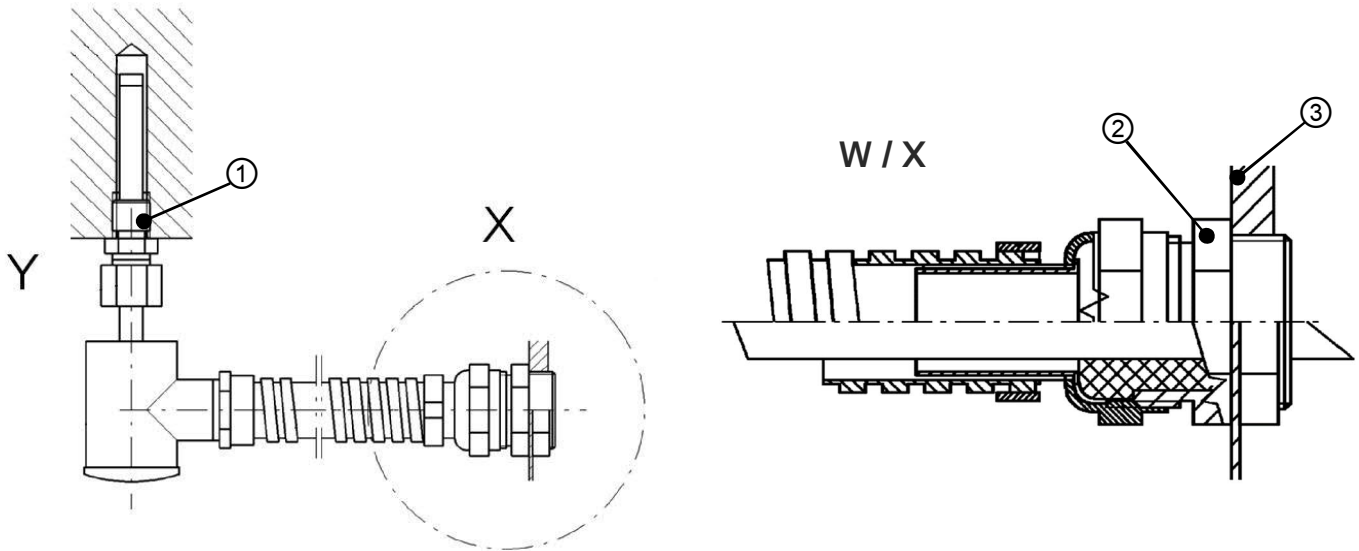
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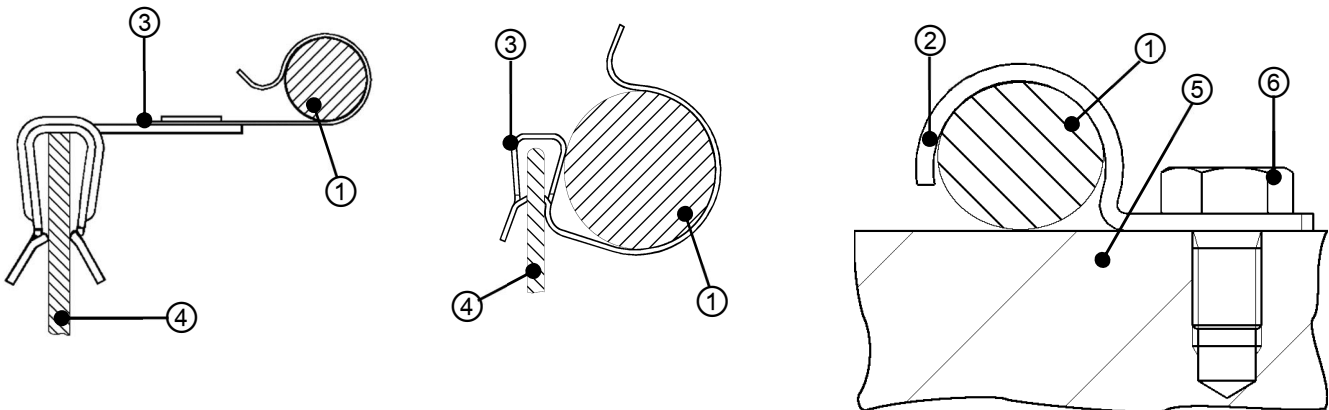
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Figure 6: Detailed drawings for



- (1) Bearing thermometer (PT100 resistance thermometer)
- (2) Screw connection
- (3) Auxiliary terminal box / stator frame

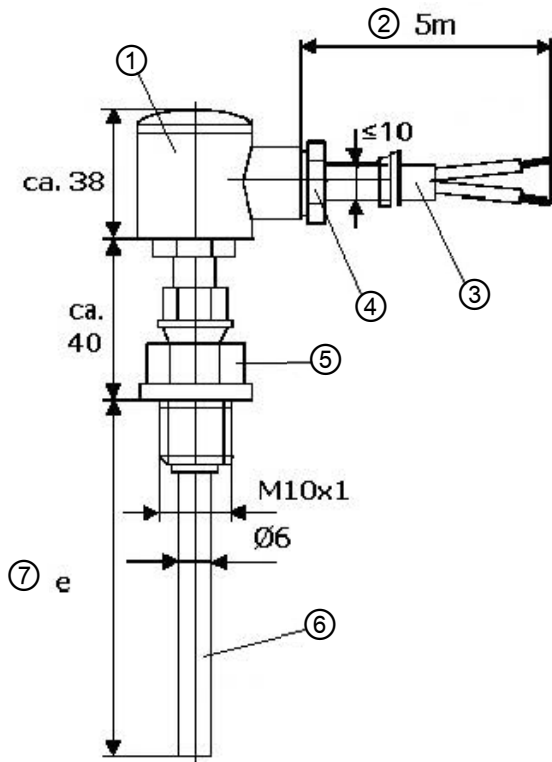
Figure 7: Exterior cable routing in conduit, mounting types:



- (1) Conduit with cable
- (2) Gripper clamp
- (3) Wiring clip
- (4) Pathway / cooling fin
- (5) Housing
- (6) Screw

| | | | |
|--|--|--------------------------|------------------------------------|
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Figure 8: Resistance thermometer

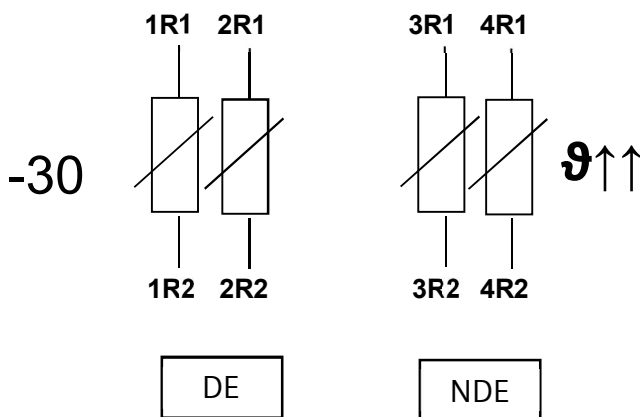


- (1) **Connection head** made of stainless steel, nickel-plated or bare brass
- (2) **Cable length**
- (3) **Connection cable**
- (4) **Cable gland**
M20x1,5 made of nickel plated brass or plastic
- (5) **Screw connection**
Male connector to DIN 3852-B;
 - Steel, corrosion-resistance, can be shifted (Standard) or
 - Steel, with anti-corrosion protection, soldered onto the sensor body
- (6) **Protective tube** with measuring insert manufactured out of stainless steel; protective tube insulation: Heat shrink tubing, resistant to mineral and synthetic oils
- (7) **Nominal length (e)**

5 Electrical connection

The figures 9 to 11 show the electrical connections of the resistance thermometer.

Figure 9: Bearing thermometer connection



- 30 Bearing thermometer
- ϑ↑↑ Resistor whose resistance changes as a function of the temperature
- DE Drive-End
- NDE Non-Drive End

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Terminal strip:

Figure 10: Example of terminal strip assignment

| Terminal strip - X1 | | Link | | Term.No. | | Destination / Item designation | |
|------------------------|---|------|--|----------|---|-----------------------------------|--|
| A | ○ | ● | | PE | c | | |
| B | ○ | ● | | PE | c | | |
| A | ○ | ● | | 1 | c | -30:1R1 | |
| B | ○ | ● | | 2 | c | -30:1R2 | |
| A | ○ | ● | | 3 | c | -30:2R1 | |
| B | ○ | ● | | 4 | c | -30:2R2 | |
| A | ○ | ● | | 5 | c | -30:3R1 | |
| B | ○ | ● | | 6 | c | -30:3R2 | |
| A | ○ | ● | | 7 | c | -30:4R1 | |
| B | ○ | ● | | 8 | c | -30:4R2 | |

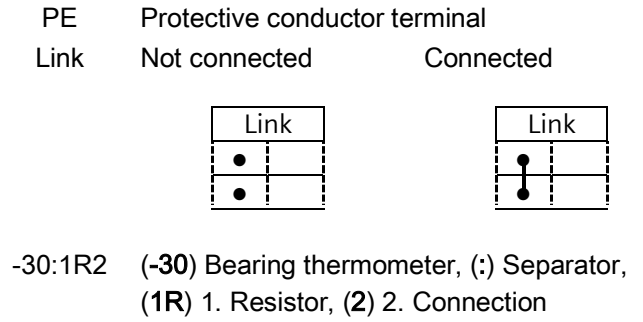
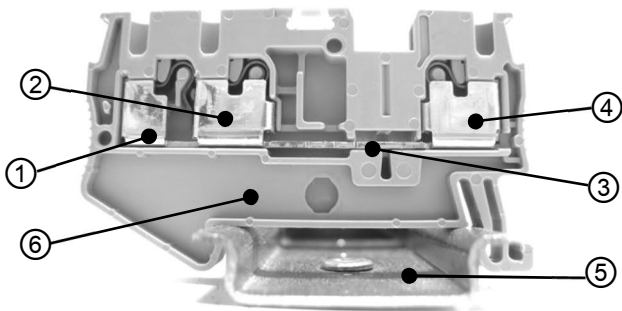


Figure 11: Terminal strip with rail (profile element)



- (1) Output (A)
- (2) Output (B)
- (3) Busbar
- (4) Input (C): Connection PT100
- (5) Rail (steel, zinc plated)
- (6) Housing (plastic)

| | | | |
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6 PT100 slot resistance thermometers without surge arrester

1 Description


For electrical machines, alternating loads or switching operations can result in significant thermal stressing of the winding insulation, which reduces the motor service life. To prevent this happening, resistance thermometers should be used for monitoring.

2 Technical data

| | |
|-----------------------------------|--|
| Implementation | Normal, Ex |
| Type | NWT-C-PT100/X/2-Sx8x100 |
| | NWT: Slot resistance temperature sensor |
| | C: 1 chip (measuring sensor) |
| | PT100: Sensor material: Platinum (100 Ω at 0 °C) |
| | X: A Tolerance class A |
| | B Tolerance class B [Standard] |
| | 2: Two-wire element |
| | Sx8x100: Sensor dimensions: Thickness x width x length (in mm) |
| | S: Thickness: 2 mm or 3 mm |
| Operating range | -40 to +180 °C |
| Connection | Two wires from the element up to the terminal box Two, three or four-wire input from the terminal box |
| Required terminals | 12 |
| Mounting position | Two slot resistance thermometers for each phase at the hottest points of the winding, between the upper bar and lower bar, distributed at equal intervals around the circumference |
| Input signal | Rated current of each measuring resistor 2 mA (max. 5 mA) |
| Power frequency withstand voltage | 3 kV / 50 Hz 1 min |
| Impulse withstand voltage | 10 kV (T1 / T2 = 2.5 / 50 μs) |
| Manufacturer | Ephy-Mess GmbH, 65205 Wiesbaden-Delkenheim, Germany Heinz Messtechnik GmbH, 98716 Elgersburg (Thuringia), Germany |

Notes

- If required, a calibration certificate can be ordered at the same time.
- Evaluation units are not included in the scope of delivery.

| | | | | | | |
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3 Principle of operation

The chip resistance thermometer uses, as temperature sensor, a structured layer (measuring resistor) manufactured out of platinum mounted on a carrier material. The resistance of this resistor changes with respect the temperature according to a specific, reproducible basic value series. Since a constant current flow through the sensor, the change in resistance is approximately proportional to the voltage change. This means that the temperature change can be reproduced by the voltage change.

The active length for the measurement is limited to the size of the thin layer sensor (point measurement) and is calibrated at 0 °C for 100 Ω ± 0.1 Ω. The basic values of the resistors (the relationship between the resistance and temperature) as well as the permissible deviations are defined in IEC 60751.

Characteristic values for the platinum measuring sensor PT100:

Table 1: Basic value series (IEC 60751)

| °C | Ω | °C | Ω |
|-----|--------|-----|--------|
| -50 | 80.31 | 80 | 130.90 |
| -40 | 84.27 | 90 | 134.71 |
| -30 | 88.22 | 100 | 138.51 |
| -20 | 92.16 | 110 | 142.29 |
| -10 | 96.09 | 120 | 146.07 |
| 0 | 100.00 | 130 | 149.83 |
| 10 | 103.90 | 140 | 153.58 |
| 20 | 107.79 | 150 | 157.33 |
| 30 | 111.67 | 160 | 161.05 |
| 40 | 115.54 | 170 | 164.77 |
| 50 | 119.40 | 180 | 168.48 |
| 60 | 123.24 | 190 | 172.17 |
| 70 | 127.08 | 200 | 175.86 |

Table 2: Deviation limit (IEC 60751)

| Class | Deviation limit in °C |
|-----------------|-----------------------|
| A *) | $0.15 + 0.002 * [t]$ |
| B [standard] *) | $0.30 + 0.005 * [t]$ |

[t] is the numerical value of the temperature in °C, without taking the sign into account
 *) only valid for three or four-wire input

Figure 1: Deviation limit (IEC 60751) Class B, standard

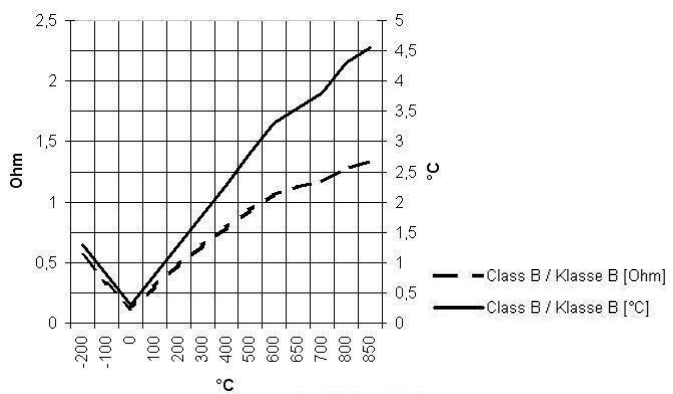
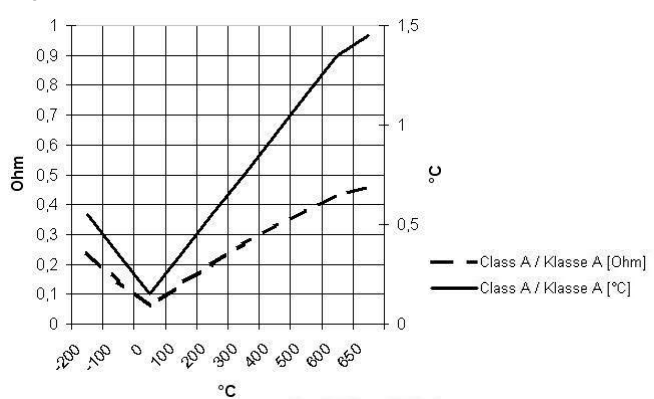


Figure 2: Deviation limit (IEC 60751) Class A



NOTICE

The resistance thermometer should only be checked with a single-dial measuring bridge in "Wheatstone connection"!

| | | | |
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4 Installation

Mounting position and cable installation for high voltage motors

Figure 3: Mounting position and cable installation for ...DKK...

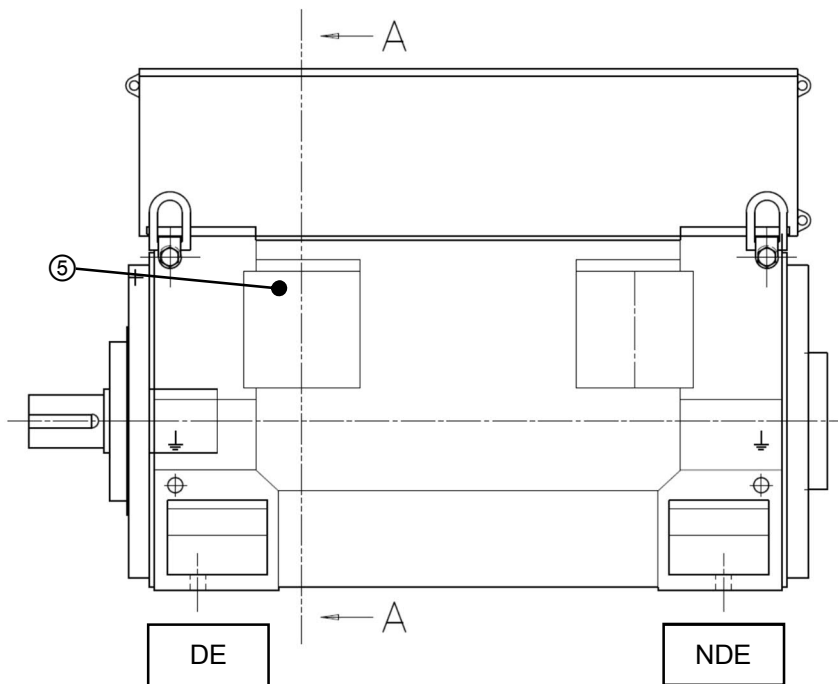
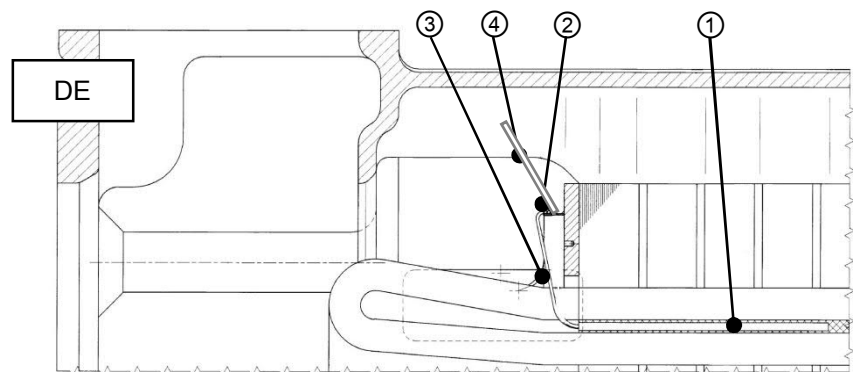
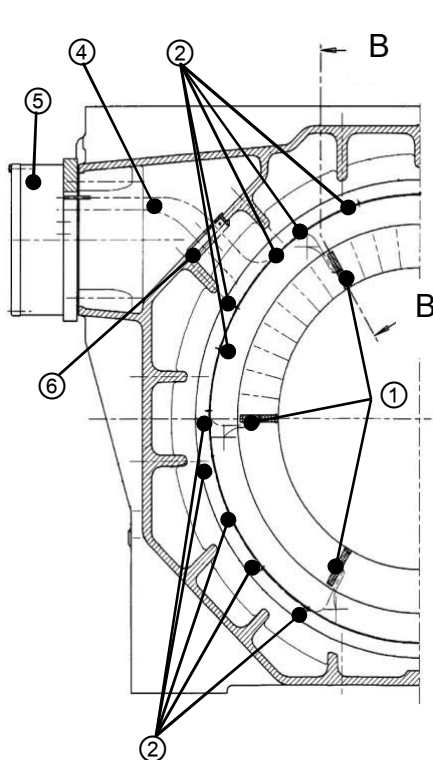


Figure 4: Section A-A

Figure 5: Section B-B



- (1) Slot resistance thermometer
- (2) Connection cables with insulating tubing and PE fabric tape fastened at the welded-on slotted banding
- (3) Insulation sleeve
- (4) Cable ends connected in the auxiliary terminal box according to circuit diagram
- (5) Auxiliary terminal box
- (6) Gland plug
- DE Drive End
- NDE Non-Drive End



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Figure 6: Mounting position and cable installation for ...DOR... , ...DWR....

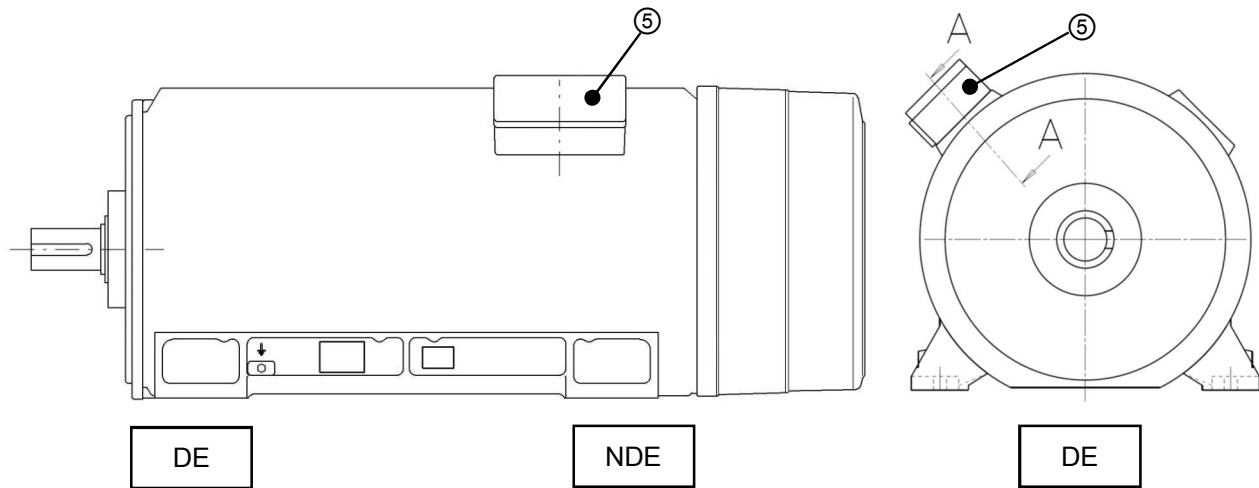
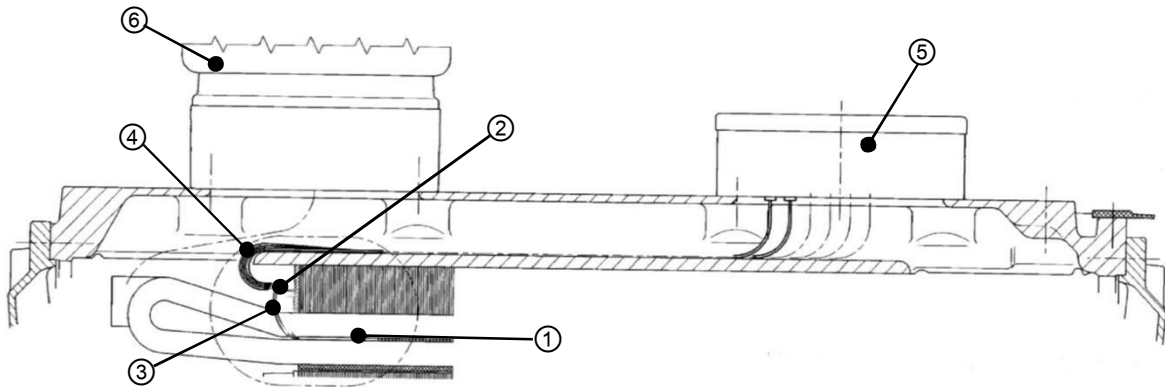


Figure 7: Section A-A



- (1) Slot resistance thermometer
 - (2) Connection cables with insulating tubing and PE fabric tape fastened at the welded-on slotted banding
 - (3) Insulation sleeve
 - (4) Cable ends connected in the auxiliary terminal box according to circuit diagram
 - (5) Auxiliary terminal box
 - (6) Main terminal box
- DE Drive End
NDE Non-Drive End


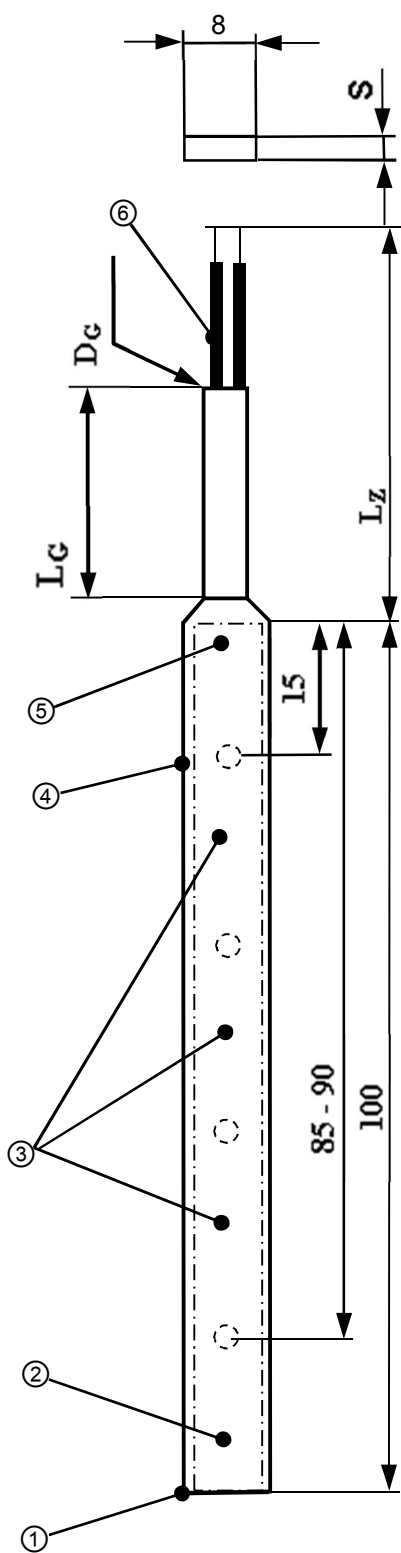
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Figure 8: Slot resistance thermometer



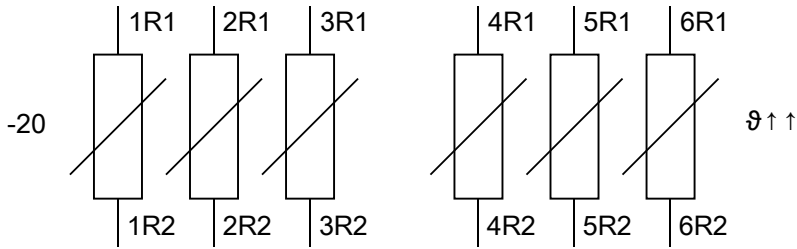
- (1) Carrier assembly
For electrical and mechanical protection as well as strain relief, the sensor is embedded in a carrier assembly. All materials used as a minimum comply with temperature class H.
 - (2) Measuring point (PT100) for the standard version
 - (3) Additional measuring points (PT100) for the multi-chip version
 - (4) Shrink-on sleeve
 - (5) Coated glass reinforced fabric tubing (optional)
 - (6) Measurement cable
Cross section: 0.56 mm²
Insulation: PTFE
- LG Length of the coated glass tubing: 150 mm
 DG Diameter of the coated glass tubing: 4 mm
 LZ Feeder line length: 5000 mm
 S Thickness depending on the version, 2 mm or 3 mm

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5 Electrical connection

The following figures 9 to 11 show the electrical connection of the 6-slot-resistance thermometer.

Figure 9: Connection of the 6 slot resistance thermometers



- 20 Slot resistance thermometer

⤴↑↑ Resistor whose resistance changes as a function of the temperature

Terminal strip

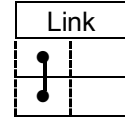
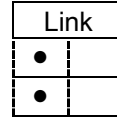
Figure 10: Example of terminal strip assignment

| | | | | | |
|---|---|---|----|---|---------|
| A | ○ | • | PE | c | |
| B | ○ | • | PE | c | |
| A | ○ | • | 1 | c | -20:1R1 |
| B | ○ | • | 2 | c | -20:1R2 |
| A | ○ | • | 3 | c | -20:2R1 |
| B | ○ | • | 4 | c | -20:2R2 |
| A | ○ | • | 5 | c | -20:3R1 |
| B | ○ | • | 6 | c | -20:3R2 |
| A | ○ | • | 7 | c | -20:4R1 |
| B | ○ | • | 8 | c | -20:4R2 |
| A | ○ | • | 9 | c | -20:5R1 |
| B | ○ | • | 10 | c | -20:5R2 |
| A | ○ | • | 11 | c | -20:6R1 |
| B | ○ | • | 12 | c | -20:6R2 |

PE
Link

PE terminal
Not jumpered

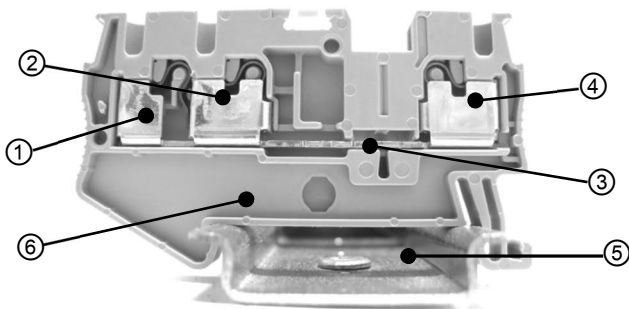
Jumpered



-20:1R2

-20 Slot resistance thermometer
: Separator
1R 1. Resistor
2 2. Connection

Figure 11: Terminal strip with rail (profile element)



- (1) Output A
 - (2) Output B
 - (3) Busbar
 - (4) Input C: Connection PT100
 - (5) Rail (steel, zinc-plated)
 - (6) Housing (plastic)
- Terminals A, B and C have the same potential.



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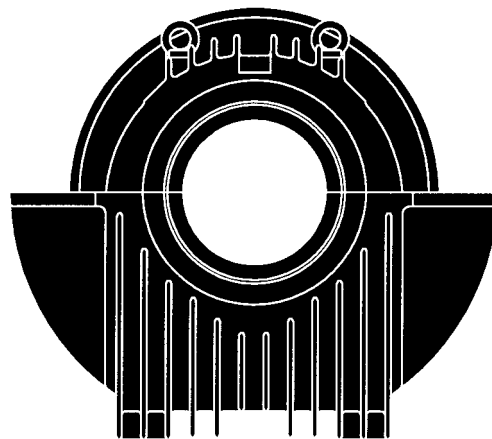
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Slide Bearings Type EM with self lubrication



RENK AKTIENGESELLSCHAFT
Werk Hannover
Weltausstellungsallee 21
D - 30539 Hannover
Telephone: (0511) 8601-0
Telefax: (0511) 8601-266
e-mail: gleitlager.hannover@renk-ag.com
<http://www.renk.de>

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Bearing Coding

Maintenance and Inspection

| ① | ② | ③ | ④ | ⑤ | ⑥ |
|------|-----------------------------------|---|--|---|------------------|
| Type | Housing | Heat Dissipation | Shape of Bore and Type of Lubrication | Thrust part | Size - Diameter |
| E | M - centre flange mounted bearing | N - natural cooling W - water cooling (finned cooler in oil sump) | L - plain cylindrical bore with loose oil ring | Q - without thrust part (non locating bearing) | 9 80≤D≤100 |
| | | | | B - sliding surfaces with oil grooves (locating bearing) | 11 100≤D≤125 |
| | | | | | 14 125≤D≤160 |
| | | | | | 18 160≤D≤200 |
| | | | | E - taper land faces for one sense of rotation (locating bearing) | 22 200≤D≤250 |
| | | | K - taper land faces (locating bearing) | 28 250≤D≤315 | |

Example for bearing coding:

① ② ③ ④ ⑤ ⑥
 E M N L Q 22-200

Type E slide bearing with centrally flanged - mounted housing, natural cooling plain cylindrical bore with loose oil ring, non locating bearing without thrust part, size 22, diameter 200.

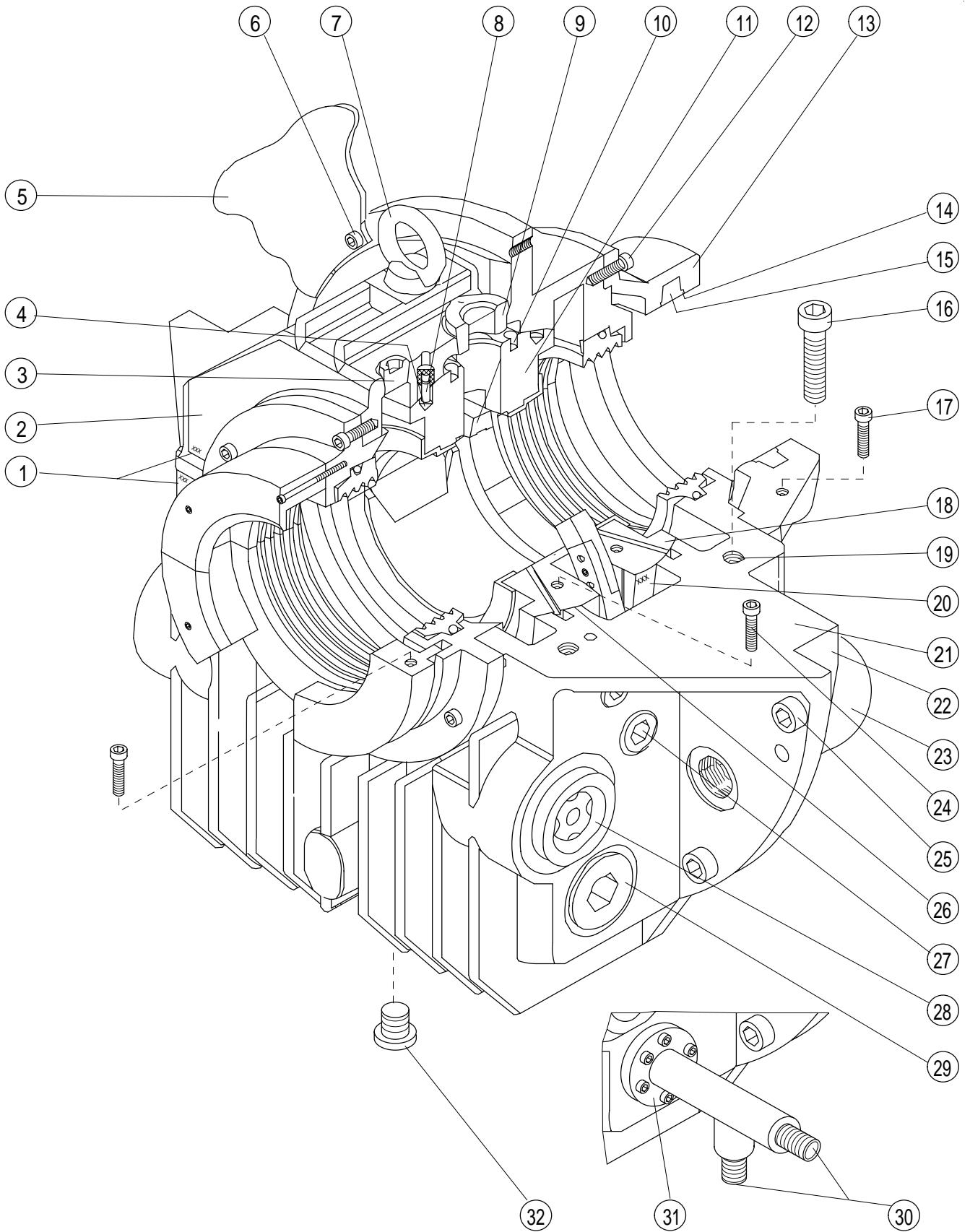
Shaft seals

- Type 10 - floating labyrinth seal (IP 44)
- Type 11 - floating labyrinth seal with dust flinger (IP 54)
- Type 12 - floating labyrinth seal with baffle (IP 55)
- Type 20 - rigid labyrinth seal (IP 44)
- Type 21 - rigid labyrinth seal with dust flinger (IP 54)
- Type 22 - rigid labyrinth seal with baffle (IP 55)

General Drawing

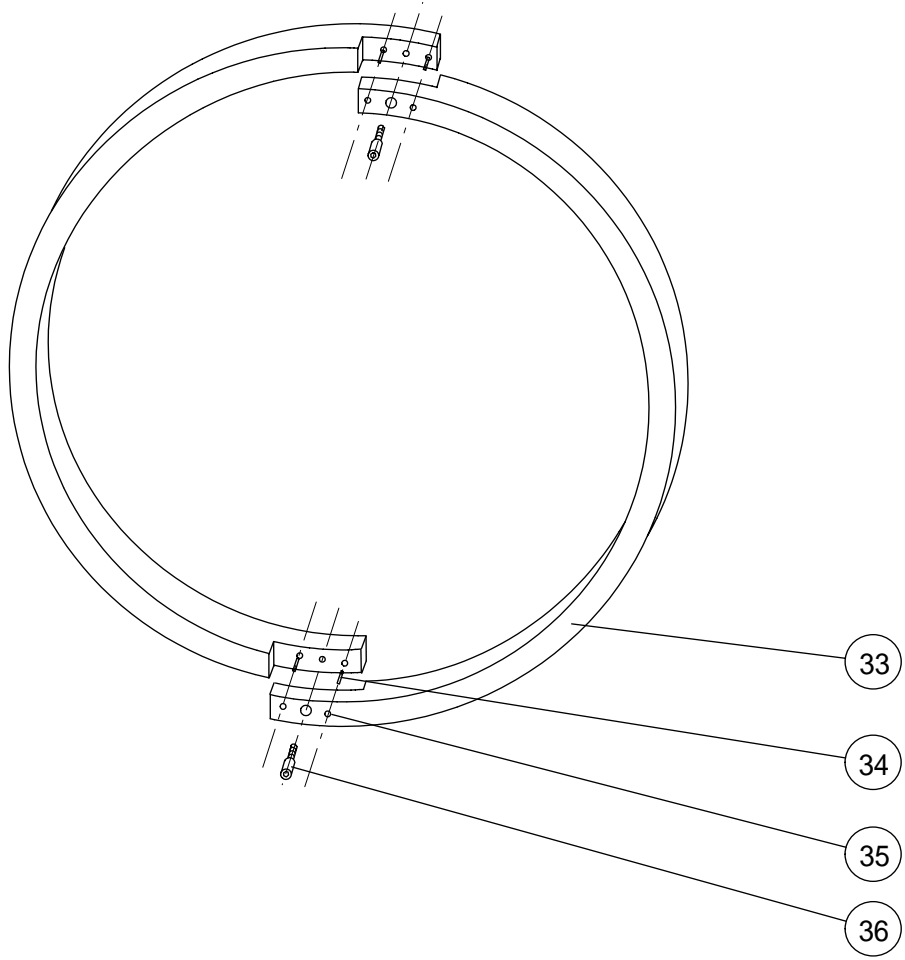
Slide Bearing EM

with self lubrication



- 1 Engraved numbers - housing
- 2 Top half of the housing
- 3 Oil filling hole
- 4 Positioning pin nut
- 5 Plate (Assembly opening)
- 6 Screw
- 7 Eye bolt
- 8 Positioning pin
- 9 Top sight glass
- 10 Tapped hole (in the top and bottom halves of the shell, up size 14)
- 11 Top half of the shell
- 12 Screw
- 13 Machine seal
- 14 Hamp packing seal groove
- 15 Hamp packing
- 16 Screw (split line of the housing)
- 17 Screw (split line of the machine seal)
- 18 Bottom half of the shell
- 19 Tapped hole
- 20 Engraved number - shell
- 21 Bottom half of the housing
- 22 Recess
- 23 Pressure equalizing hose
- 24 Screw (split line of the shell)
- 25 Screw
- 26 Spherical seating
- 27 Tapped hole for temperature measurement of the journal part
- 28 Oil sight glass
- 29 Tapped hole for the oil sump temperature measurement
- 30 Outlet/Inlet cooling water (Type E.T..)
- 31 Cooler (Type E.T..)
- 32 Hexagon head plug (Oil drain plug)

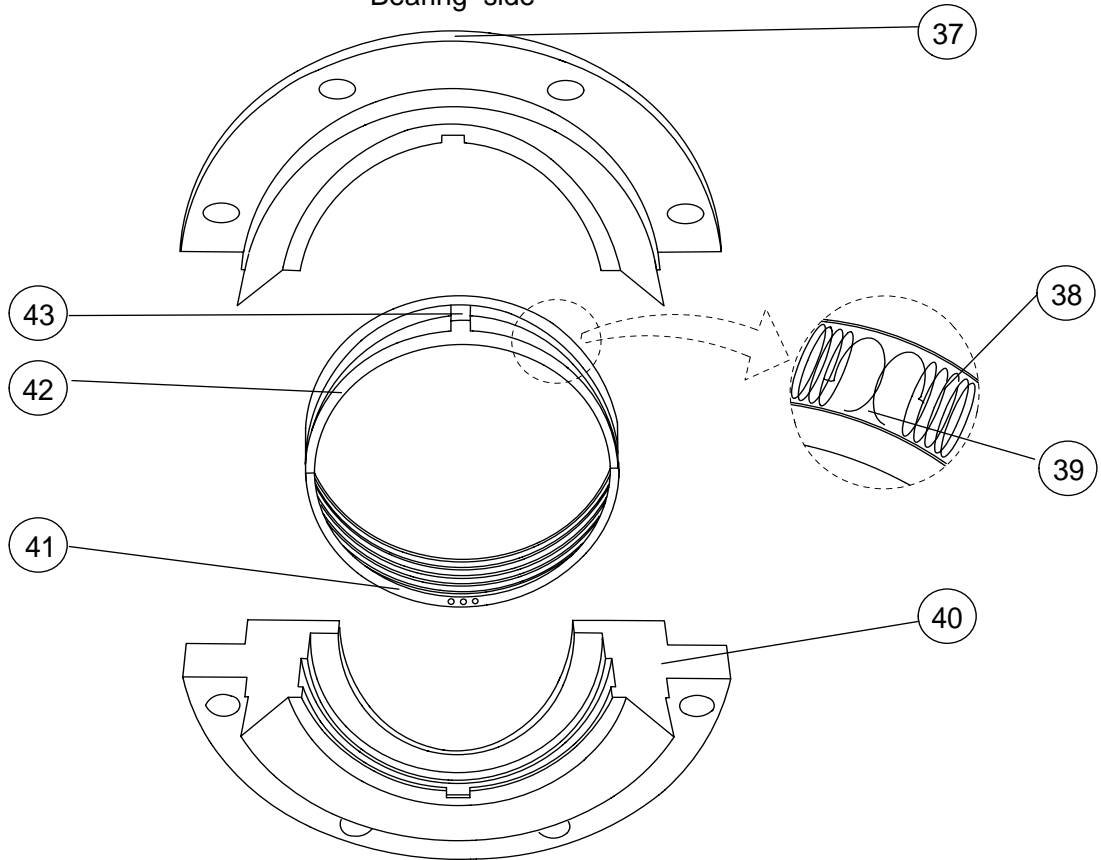
**General Drawing of the
Loose Oil Ring**



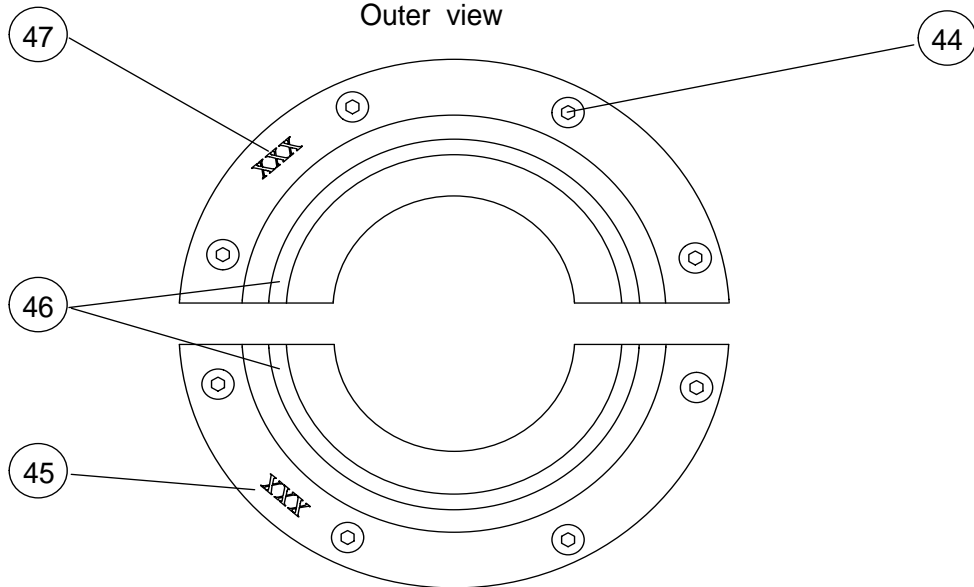
- 33 Loose oil ring
- 34 Dowel pin
- 35 Hole
- 36 Screw

**General Drawing of the
Floating Labyrinth Seal
with Seal Carrier**

Bearing side

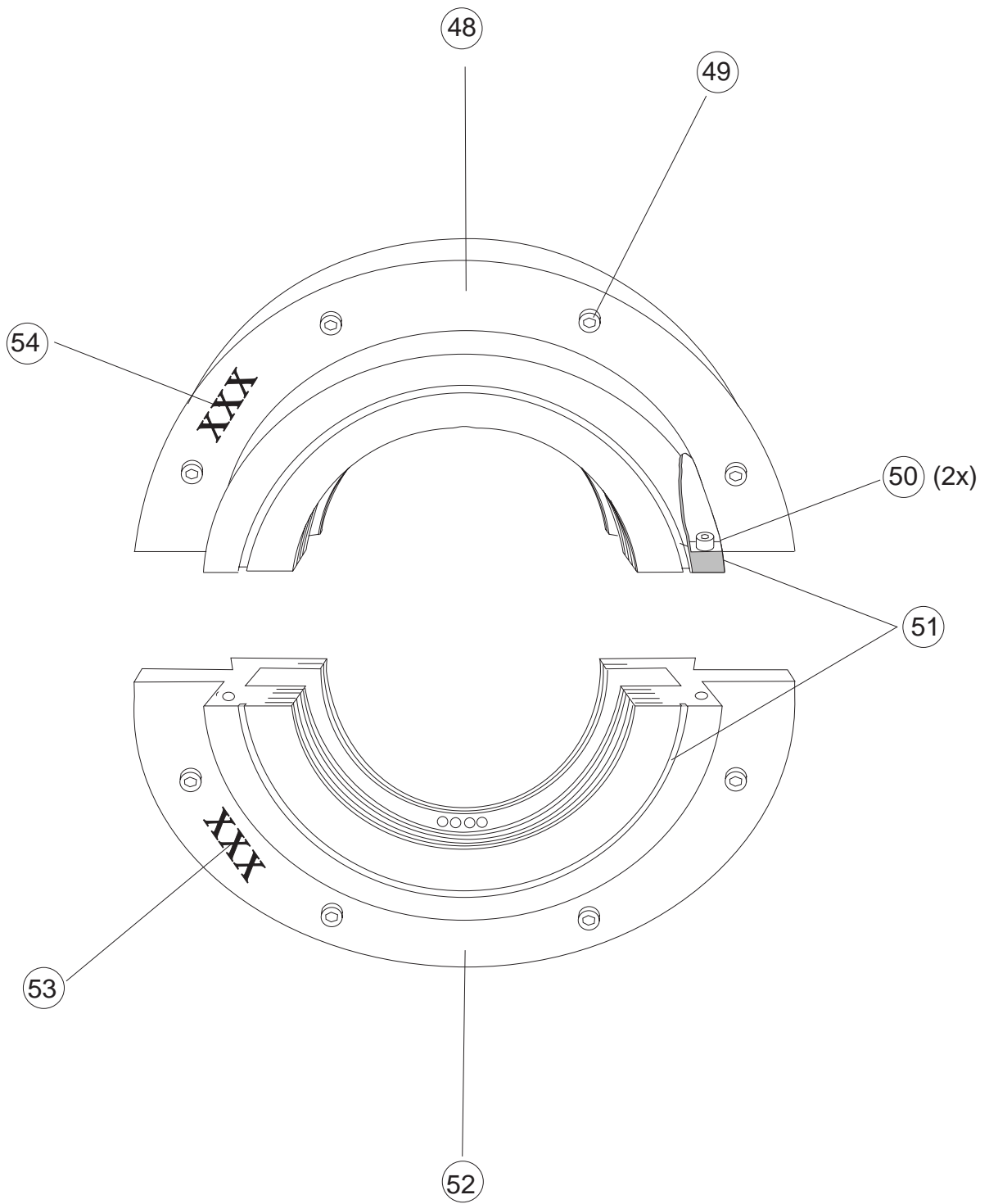


Outer view



- 37 Seal carrier - top half
- 38 Garter spring
- 39 Groove
- 40 Seal carrier - bottom half
- 41 Bottom half of the seal
- 42 Top half of the seal
- 43 Anti - rotation pin
- 44 Screw
- 45 Engraved number
- 46 Groove (Type 11)
- 47 Engraved number

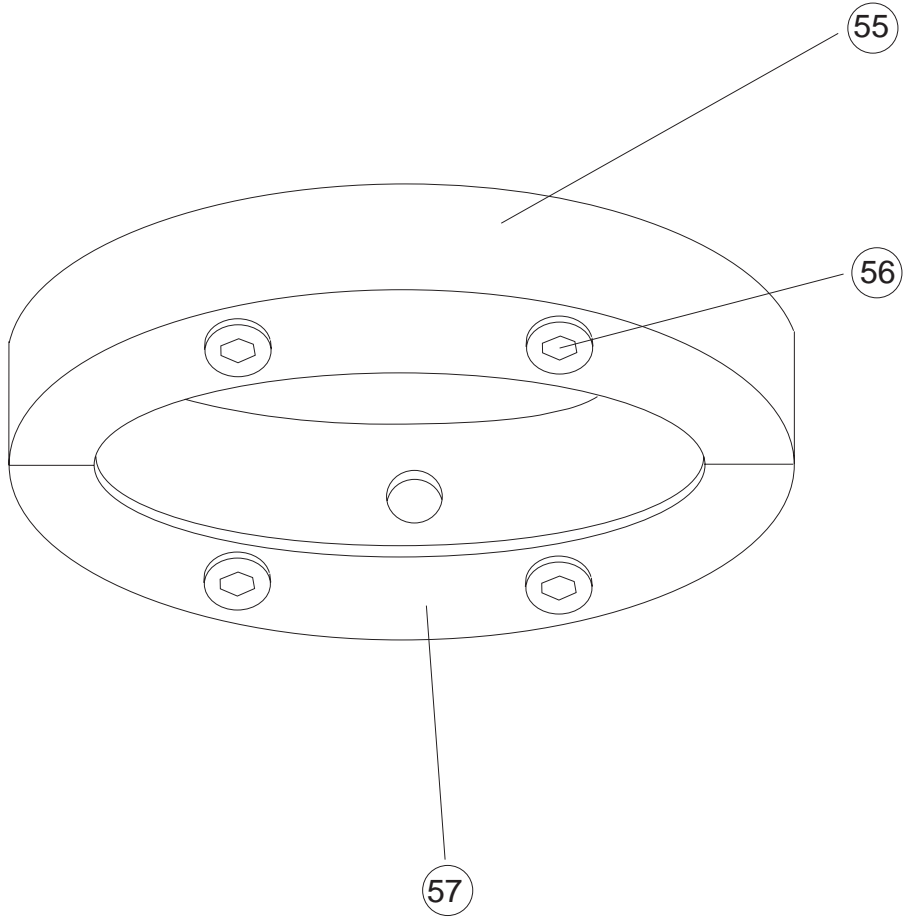
**General Drawing of the
Rigid Labyrinth Seal**



- 48 Rigid labyrinth seal - top half
- 49 Screw
- 50 Screw (split line)
- 51 Groove (Type 21)
- 52 Rigid labyrinth seal - bottom half
- 53 Engraved number
- 54 Engraved number

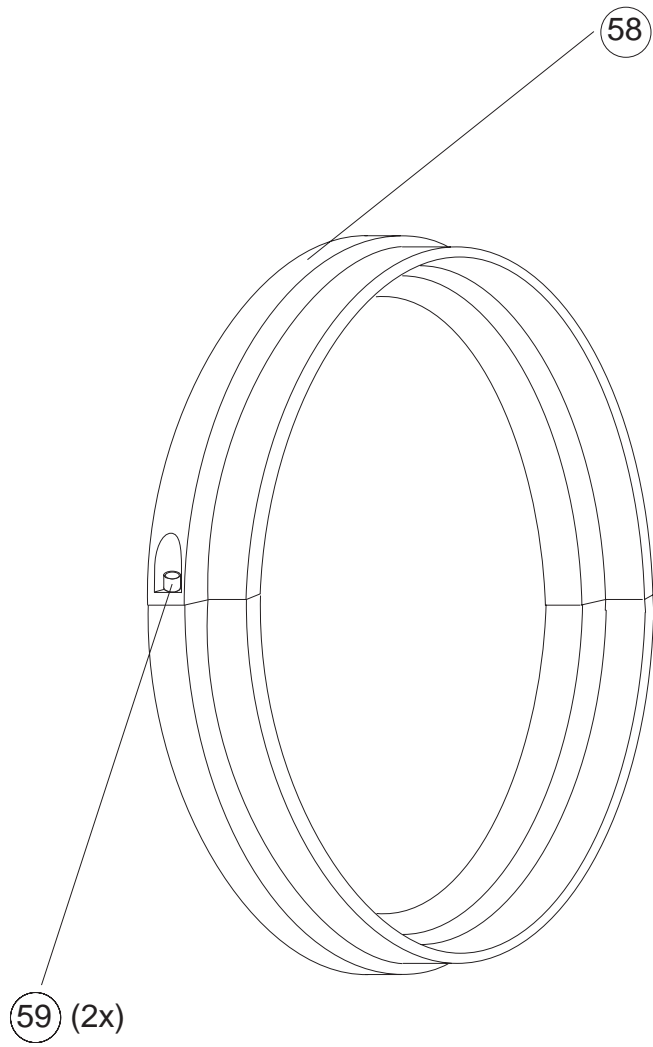
General Drawing

Baffle



- 55 Baffle - top half
- 56 Screw
- 57 Baffle - bottom half

**General Drawing of the
Dust Flinger**



- 58 Dust flinger
- 59 Screw (split line)

1 Considerations for Use

The instructions for maintenance and inspection are addressed to qualified technical personnel (fitters, mechanic installers, mechanical engineers).

Read these instructions carefully before starting assembly.

Slide bearings of type EM are almost universally used in the engineering industry. Therefore it is not possible to provide detailed information on all possible types and range of applications for these bearing types. For instance, the position of the connection points for supply and monitoring equipment is determined by the place of application (in the following called " installation "). Please keep ready the guidelines with the technical documentation before starting maintenance and inspection of the slide bearings.

Additional technical documentation with detailed information is supplied in case of special design bearings. Please contact RENK Export or Domestic Department for supplementary information on bearings. Please indicate the bearing coding and the full reference number, too.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:



Danger!

Warning of dangers for personnel.
Example: Warning of injury

Attention!

Warning of damage for the bearing or installation.

Useful recommendations and additional information are framed.

EMW..

This is how chapters, instructions or recommendations are marked when referring to a single type or size of a bearing.

Example: Slide bearing type E with water cooling

- Instruction follows.
- Beginning of an enumeration.
- () This is how the different parts of a bearing as described in the general drawings (numbers) are marked in the text.
- Use the enclosed check-list before starting assembly or operation. Copies available on request.
- The check list provides the experienced mechanical fitters of RENK bearings with the necessary instructions for installation and operation.

2 Safety Instructions



Danger!

The maintenance and inspection of the slide bearings should be carried out by:

- persons nominated by the safety representative
- persons correspondingly trained and instructed
- persons with knowledge on appropriate standards, regulations and accident prevention rules
- persons with knowledge on first-aid measures and local rescue centres.



Warning of injury!

Before starting work on the bearing:

- Switch off the installation.
- Make sure the installation is not in operation.

Never lift or transport machines, etc. by the bearing eye bolts. These are only intended for assembly and dismantling of the bearing !



Warning of injury!

Do not grab such heavy bearing parts as the housing during assembly or dismantling work. This could result in bruising or injury to hands !

Attention!

All metal parts of a slide bearing consisting of top and bottom part such as the housing, shells, shaft seals are marked by engraved numbers. Fit together only the parts with the same number.

Attention!

In case

- the admissible bearing temperature exceeds 15 K

- inadmissible vibrations occur
- unusual noises or odours are noticed
- monitoring equipment triggers alarm

shut down the installation and inform the maintenance personnel in charge.

Attention

Do not operate the bearing below the transition speed values indicated in the bearing calculation, thus avoiding inadmissible operating conditions, which could lead to damage to the bearing.

Attention!

Please observe our leaflet Technical Information No. 85 which refers to various sealing compounds for extended technical applications.

3 Operating Instructions after Standstill

- Clean the external parts of the bearing. Dust and dirt impede the radiation of the heat.
- Check with the instructions to determine if an oil change is necessary. Depending on the duration of the standstill an oil change is either prescribed or recommended. Carry out the oil change as indicated in Chapter 5.
- Check the oil level
- If necessary, refill with lubricant by using the oil filling hole (1).
The refilling oil should be of the same type as already used.
The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass
maximum oil level: top of the oil sight glass

- Retighten the screws (16) to the following torque rates:

| | | | | | | |
|--|----|----|-----|-----|-----|------|
| Bearing Size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] for $\mu_{\text{tot}} = 0,1$ (lightly oiled) | 40 | 69 | 170 | 330 | 570 | 1150 |

- Check that the top sight glass (9) is firmly in position.
- Check that oil sight glass (28) is firmly in position.

In cases where a thermo sensor or/and an oil sump thermometer are used:

- Check that they are correctly fitted (see also the manufacturer's instructions).
- Retighten all screw plugs in the connection holes (27), (28), (32) to the necessary torque rates:

| | | | | | | | | |
|--|-------|-------|-------|-----|---------|---------|-----|---------|
| Screw plug threads | G 3/8 | G 1/2 | G 3/4 | G 1 | G 1 1/4 | G 1 1/2 | G 2 | G 2 1/2 |
| Torque [Nm] for plugs with moulded on plastic seal | 30 | 40 | 60 | 110 | 160 | 230 | 320 | 500 |
| Torque [Nm] for plugs with elastic seal | 34 | 60 | 85 | 130 | 240 | 300 | 330 | 410 |

- Check that the temperature monitoring equipment is functioning correctly.
- EMW..**
- Check that the functioning of the water cooler is functioning correctly.

The bearing is now ready to work.

4 Maintenance Schedule

| Maintenance work | Deadline |
|----------------------------------|--|
| Exterior cleaning of the bearing | every 100-1000 hours |
| Oil change | Bearing in reversing operation every 5000 operating hours. Bearing in continuous operation every 8.000 operating hours (please observe also the indications for the use of the lubricating oil). |
| Bearing inspection | During prevention maintenance work for the installation. Immediately if: <ul style="list-style-type: none">● the bearing temperature exceeds 15 K over the indicated value (see the EDP-calculations)● unusual operating noises occur● unusual changes of the lubricating oil become visible● increased oil level in the case of bearing type EMW... |

5 Oil Change

Risk of pollution!

Please observe the instructions for the use of the lubricating oil. The manufacturer can provide information on waste oil disposal.

- Shut down the installation and secure it against unintended operation.
- Take all necessary measures to collect the whole quantity of the lubricating oil.
- Drain off the lubricating oil while still in a warm condition. Impurities and residues will thus be scavenged.
- Unscrew the hexagon head plug (32). Drain off the lubricating oil and collect it.

Attention!

In cases where the lubricating oil contains unusual residues or is visibly changed, eliminate the causes. If necessary, carry out an inspection.

- Tighten the hexagon head plug (32) to the following torque rates:

| | | | | | | |
|--------------|----|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 30 | 30 | 30 | 40 | 60 | 60 |

- Remove the screw plugs from the oil filling hole (3).

Attention!

Make sure that no impurities get into the bearing.

- Use a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filling hole (3) up to the middle point of the oil sight glass (28).

The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass
maximum oil level: top of the oil sight glass

Attention!

- Not enough lubricant leads to temperature rises and thus to damage of the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant could apply a braking force to the oil ring,, thus leading to damages to the bearing.

- Tighten the screw plug into the oil filling hole (3) to the following torque rates:


| | | | | | | |
|--------------|----|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 30 | 30 | 30 | 40 | 60 | 60 |

6 Dismantling of the Bearing

6.1 Tools and equipment

- Following tools and equipment are necessary:
 - Allan key set
 - Wrenching key set
 - Open-jawed spanner set
 - Feeler gauges (up 0,05 mm)
 - Caliper gauge
 - Emery paper, plain scraper
 - Oil stone
 - Lifting equipment
 - Permanent sealing compound
 - Clean (close weave) rags
 - Oil with the correct viscosity (see bearing type plate)
 - Detergents
 - Liquid screw locking compound (e.g. LOCTITE 242)
 - Liquid sealing compound and Teflon tape.

6.2 Use of lifting equipment



Risk of injury!

Before transport or lifting, check if the eye bolts are tight! Insecure eye bolts could result in bearing becoming loose.

Before moving the bearing by the eye bolts make sure that the split line screws are tightened, otherwise the bottom half of the bearing could become detached.

Make sure that the eye bolts are not exposed to bending stress, otherwise the bolts could break.

Follow exactly the instructions for the use of the lifting equipment.

- Use lifting equipment for following assembly and transport works:

| Transport/Assembly of: | Use lifting equipment for the following bearing sizes |
|----------------------------|---|
| Whole bearing unit | 9-28 |
| Top half of the housing | 14-28 |
| Bottom half of the housing | 11-28 |
| Shells | 14-28 |

- Following steps are to be observed before using the lifting equipment:

Whole bearing unit

- Check if the screws (16) are tight:

| | | | | | | |
|--|----|----|-----|-----|-----|------|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque value [Nm] for $\mu_{\text{tot}} = 0,1$ (lightly oiled) | 40 | 69 | 170 | 330 | 570 | 1150 |

- Check if the eye bolts are tight (7).
- Connect the lifting equipment to the eye bolts (7).

**Size
22 and
28**

Sizes 22 and 28 are delivered equipped with an assembly device.

When not in use this assembly device is located in the "parking position" behind the flange and as such it is not allowed to use it as transport device.

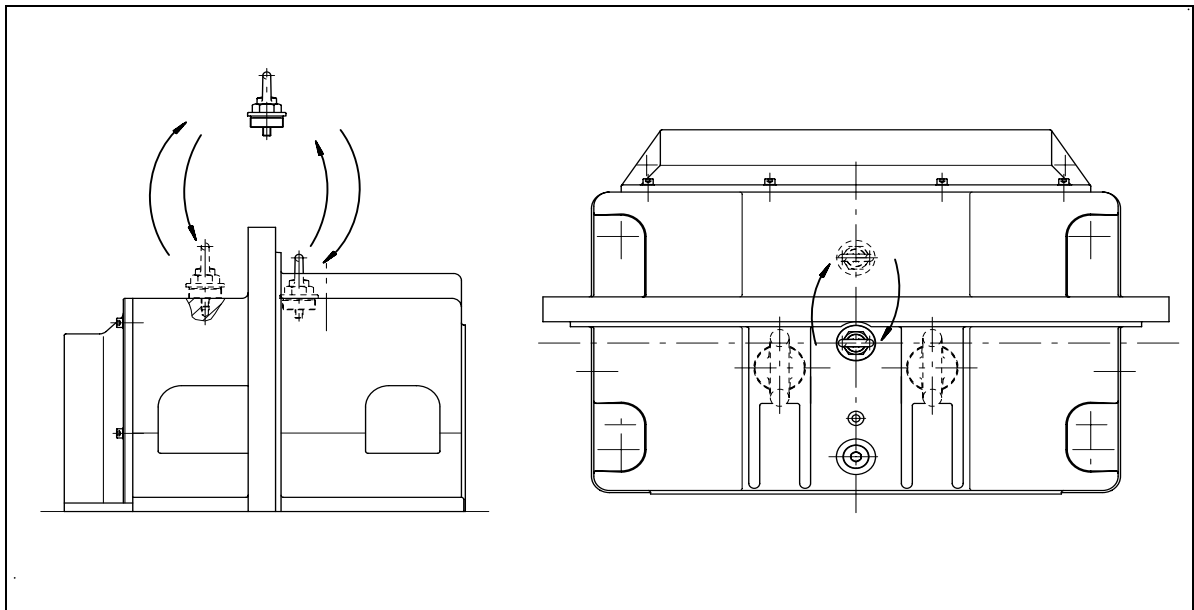


Illustration 1: Assembly device

To mount the top half of the housing remove the top sight glass and screw in the assembly device.

By using the appropriate lifting equipment and with the help of the assembly device it is possible to lift and mount the top half of the housing in a straight position.

After assembling the top half of the housing put the assembly device back into the "parking position" behind the flange and screw in the top sight glass.

Maintenance and Inspection

Top half of the housing

- Check if the eye bolts are tight (7).
- Connect the lifting equipment to the eye bolts (7).

Bottom half of the housing

- Screw two eye bolts (7) with suitable threads tight into the cross-placed opposite tapped holes (19).

| | | | | | | |
|--------------|------|------|------|------|------|------|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Tapped hole | M 10 | M 12 | M 16 | M 20 | M 24 | M 30 |

- Connect the lifting equipment to the eye bolts (7).

Shells

- Screw two eye bolts or screw hooks with suitable threads tight into the tapped holes (10):

| | | | | |
|--------------|-----|------|------|------|
| Bearing size | 14 | 18 | 22 | 28 |
| Tapped hole | M 8 | M 12 | M 12 | M 16 |

- Connect the lifting equipment to the screw hooks.

6.3 Preparation for dismantling

Attention!

Make sure that the work place is clean. Contamination and damage to the bearing, especially to the working surfaces, have a negative influence on the operating quality and could lead to premature failure.

Attention!

Do not use any violence or force!

- Shut down the installation and ensure it against unintended operation.
- Interrupt the cooling water supply.
- Dismantle all thermo sensors from the connection holes.
- Take all necessary measures to collect the lubricating oil.
- Unscrew the hexagon head plug (32) and collect the lubricating oil.

EMW..

Risk of pollution!

Please observe the instructions for the use of the lubricating oil. The manufacturer can provide necessary information on waste oil disposal.

- Tighten the hexagon head plug (32) to the following torque rates

| | | | | | | |
|--------------|----|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque (Nm] | 30 | 30 | 30 | 40 | 60 | 60 |

- Remove the thin metal plate (5) to get access to the assembly opening or, in the case of the split machine shield, dismantle the top half of the shield.

6.4 Dismantling of the shaft seal - outboard side

- Dismantle the outboard side seals of the bearing.
Proceed correspondingly to the seal type:

- Floating labyrinth seal (Type 10) Chapter 6.4.1
- Floating labyrinth seal with dust flinger (Type 11) Chapter 6.4.2
- Floating labyrinth seal with baffle (Type 12) Chapter 6.4.3
- Rigid labyrinth seal (Type 20) Chapter 6.4.4
- Rigid labyrinth seal with dust flinger (Type 21) Chapter 6.4.5
- Rigid labyrinth seal with baffle (Type 22) Chapter 6.4.6

Type 10

6.4.1 Floating labyrinth seal (Type 10)

- Loosen all screws (44) and take them out.
- Remove simultaneously in axial direction both top half (37) and bottom half (40) of the seal carrier from the housing.
- Shift a little (about 20 mm) the top half (42) of the seal. Tilt it over carefully until the garter spring (38) unbends.



Warning of injury!

During dismantling of the floating labyrinth seal hold tight the garter spring (38) which is under tension and could bounce back and lead to injury.

- Open the garter spring (38) and remove the bottom half of the seal (41) from the shaft.

Type 11

6.4.2 Floating labyrinth seal with dust flinger (Type 11)

- Dismantle the dust flinger (58). Loosen the screws (59) and take out the dust flinger (58) from the groove (46) of the seal carrier. Remove both halves of the dust flinger.
- Go on as indicated for type 10 (see Chapter 6.4.1).

Type 12

6.4.3 Floating labyrinth seal with baffle (Type 12)

- Disconnect both top (66) and bottom (57) halves of the baffle by untightening the screws (56).
- Go on as indicated for type 10 (see Chapter 6.4.1).

Type 20

6.4.4 Rigid labyrinth seal (Type 20)

- Loosen all screws (49) and take them out.
- Take out the screws (50).
- Remove simultaneously in axial direction both top (48) and bottom (52) halves of the rigid labyrinth seal.

Type 21

6.4.5 Rigid labyrinth seal with dust flinger (Type 21)

- Dismantle the dust flinger (58). Loosen the screws (59) and take out the dust flinger (58) from the groove (51) of the rigid seal. Remove both halves of the dust flinger.
- Go on as indicated for type 20 (see Chapter 6.4.4).

Type 22

6.4.6 Rigid labyrinth seal with baffle (Type 22)

- Unscrew the top half (55) and the bottom half (57) of the baffle by untightening the screws (56).
- Go on as indicated for type 20 (see Chapter 6.4.4).

6.5 Opening of the machine seal

- Loosen the screws (17) of the machine seal.

6.6 Dismantling of the top half of the housing

EM.V.

- Unscrew the screw plug with the welded-on positioning pin.

**Size 22
and 28**

- Replace the top sight glass (9) by the assembly device. The top half of the housing can be lifted and transported by using the assembly device, well tight, and the appropriate lifting equipment.
- Remove the screws (16) and lift the top half of the housing.
- Lift the top part of the housing in axial direction until the top part of the flange becomes free.
- Go on lifting until the top part of the housing can be moved in axial line over the shell, without touching it.

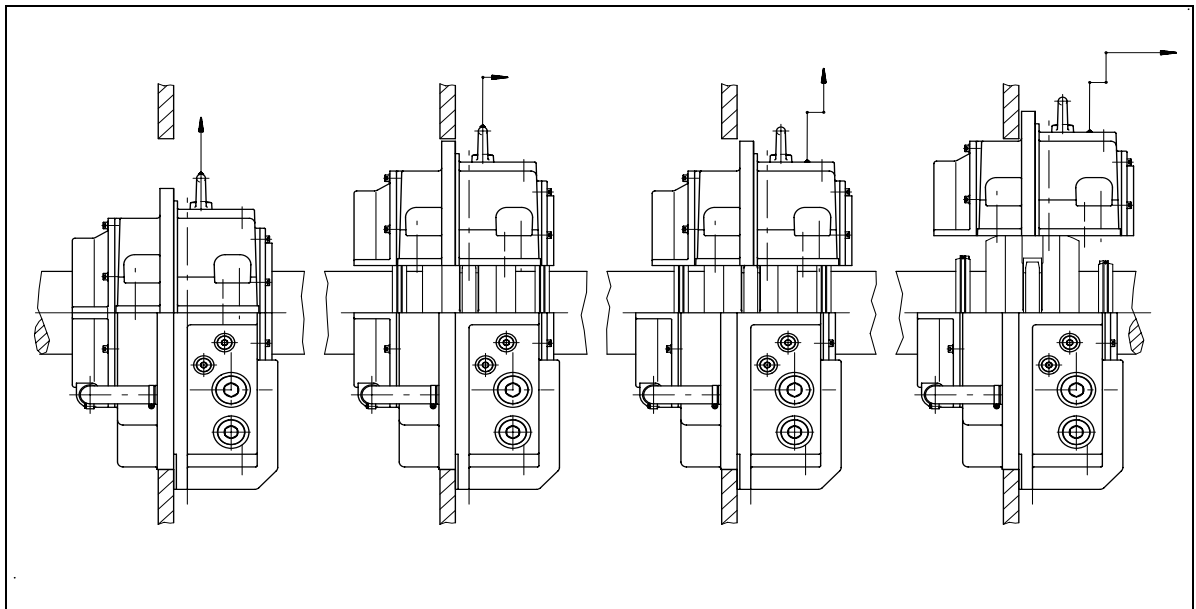


Illustration 2: Dismantling of the housing - top half

6.7 Removal of the top half of the shell

- Unscrew the screws (24) and lift the top half of the shell (11).

Attention!

Do not damage the thrust and radial working surfaces.

Attention!

In the case of insulated housings (white plastic insulating foil) avoid any jamming of the top half of the shell when you lift it up.

Jamming could lead to damage of the insulating foil in the bottom half of the housing.

EM.L.

6.7.1 Dismantling of the loose oil ring

- Open both split lines of the loose oil ring (33) by untightening and taking out the screws (36). Separate both halves of the loose oil ring (33) carefully without using any tools or other devices.

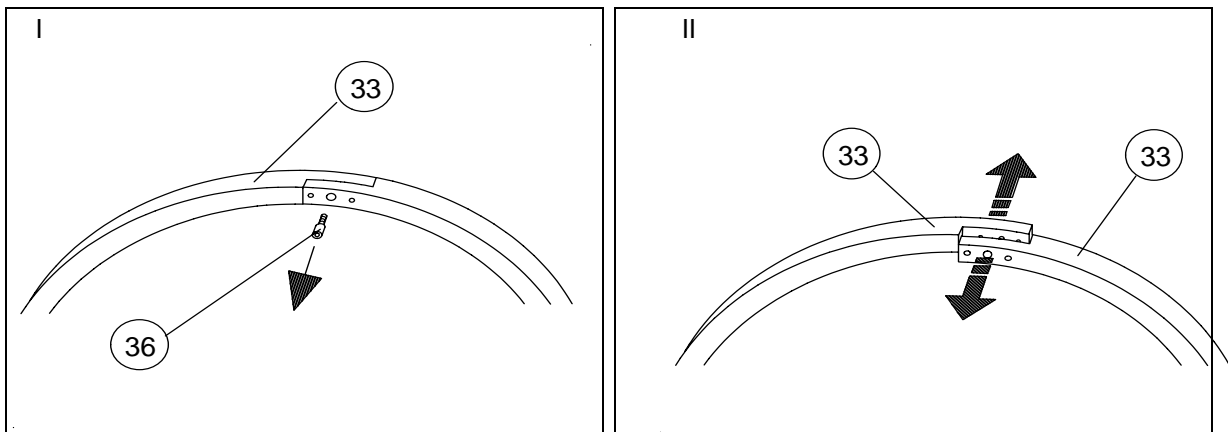


Illustration 3 Opening of the loose oil ring

To check the geometry of the loose oil ring put it together as follows:

- Press the positioning pin (34) into the holes (35).
- Adjust both halves of the loose oil ring till the split lines match each other.
- Tighten the screws (36).

6.7.2 Dismantling the machine side shaft seal

- Shift a little (about 20 mm) the top half (42) of the seal. Tilt it over carefully until the garter spring (38) unbends.



Warning of injury!

During dismantling of the floating labyrinth seal hold tight the garter spring (38) which is under tension and could bounce back and lead to injury.

- Open the garter spring (38) and turn the bottom half of the seal (41) in opposite direction from the anti-rotation pin out of the integrated seal groove of the bottom half of the housing.

6.8 Removal of the bottom half of the shell

Attention!

Make sure that all bearings mounted on a shaft line are opened. Loosen the screws at the split line of the housing.

Attention!

The lifting equipment should not come into contact with the seal and working surfaces of the shaft.

- Lift the shaft up to the point where shaft and bottom half of the shell (18) do not touch each other any more. Protect the shaft against unintended movement.
- Turn the bottom half of the shell (18) out of the bottom half of the housing (21) and remove it from the shaft.

6.9 Dismantling of the machine seal

Usually it is not necessary to dismantle the machine seal if maintenance works are carried out. However in case the machine seal must be dismantled, dismantle the bottom half of the housing.

Attention!

The assembly and dismantling of the bottom half of the bearing are fully described in the Instructions for Installation and Operation. Please observe these instructions.

After dismantling the bottom half of the housing both halves of the machine seal can be unscrewed. In the case the machine seal is equipped with a hamp packing (15), some visible changes can be noticed, such as : tallow excess, black colour of the seal due to temperature development. Even in such cases it is not necessary to renew the hamp packing (15). Colour changes will appear with a new hamp packing too, until the seal clearance adjusts during operation.

7 Cleaning and Checking of the Bearing

Attention!

Use only non-aggressive detergents such as for instance

- VALVOLINE 150
- Alkaline cleaning compounds (pH-value 6 to 9, short reaction time).



Warning of injury!

Please observe the instructions for the use of the detergents.

Attention!

Never use cleaning wool or cloth. Residues of such materials left in the bearing could lead to excessive temperatures.

– Clean the following parts thoroughly:

- top half of the housing (2)
- bottom half of the housing (21)
- top half of the shell (11)
- bottom half of the shell (18)
- sealing surfaces of the top half (37) and bottom half (40) of the seal carrier or of the rigid labyrinth seal
- loose oil ring (33).

– Check the condition of the cooler (31).

In case the cooler (31) is incrustated with oil sludge:

- Dismantle the cooler. Remove the incrustation by using for instance a wire brush.
- Install the cooler (31) into the bearing.

EMW..

- Carry out a visual check of the wear condition of all bearing parts. The following table provides information on the parts that must be replaced in case of wear. The right evaluation of the wear condition, especially of the running surfaces of the shell, implies a lot of experience. If in doubt, replace the worn part with new ones.

| Bearing part | Wear condition | Maintenance proceed |
|----------------|--|--|
| Shell | Scoring | Bearing temperature before inspection: · not increased - no new shells · increased - new shells |
| | White metal lining damaged | New shell |
| | Bow wave ridges | New shells |
| Shaft seal | Baffles broken or damaged | New shaft seal |
| Loose oil ring | Geometrical form (roundness, flatness) visibly changed | New loose oil ring |

Size 9-14

- Check the projection of the positioning pin (8) according to the values indicated below:

| | | | | | | |
|--|---|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Projection of the positioning pin (4) mm | 7 | 8 | 10 | 12 | 14 | 16 |

In case the projection is less than indicated,

- drive the positioning pin (8) through the top half of the housing (2) until the indicated value is reached.

insulated bearings

- Check the insulating layer of the spherical seating (26) of the top half (2) and bottom half (21) of the housing. In case of damage contact the RENK-sales agency in charge.

8 Assembly of the Bearing

Attention!

Remove all impurities or other objects such as screws, nuts, etc. from inside the bearing. If left inside they could lead to damage of the bearing. Cover up the opened bearing during work breaks.

Attention!

Carry out all assembly operations without making use of force.

Attention!

Secure all screws of the housing, at the split line and flange with a liquid screw locking compound (e.g. LOCTITE 242).

8.1 Fitting in the bottom half of the shell

EM..E

Attention!

Mounting the bottom half of the shell (not marked with an arrow) correctly will ease the assembly of the top half shell (marked with an arrow) (see chapter 8.4).

- Apply some lubricant to the spherical seating (26) in the bottom half of the housing (21) and to the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).
- Place the bottom half of the shell (18) on the working surface of the shaft. Turn the bottom half of the shell (18) into the bottom half of the housing (21) with the split line surfaces of both halves in true alignment.

In case the bottom half of the shell doesn't turn in easily, check the position of the shaft and the alignment of the housing

EM..B,
EM..K,
EM..E

Attention!

These operations should be carried out most carefully. The thrust parts of the bottom shell must not be damaged.

- Lower down the shaft till it sits on the bottom half of the shell (18).

8.2 Assembly of the shaft seal - machine-side

The machine-side shaft seal is, as standard, a floating labyrinth seal. The integrated seal groove is in the top and bottom halves of the housing.



Warning of injury!

During assembly hold the garter spring ends (38) securely to avoid them suddenly releasing and causing possible injury!

Check the movement of the floating labyrinth seal on the shaft in the seal area outside the housing:

- Put the garter spring (38) around the shaft and hook both ends into each other.
- Put both halves of the seal (41), (42) in their place on the shaft.
- Put the garter spring (38) into the spring groove (39).
- Turn the floating labyrinth seal on the shaft.

Attention!

The floating labyrinth seal should turn easily on the shaft. A jammed seal could lead to overheating during operation and even to shaft wear.

If the floating labyrinth seal jams,

- dismantle the seal and
- remove the worn parts of the seal carefully, by using emery paper or a plain scraper.

- Dismantle the floating labyrinth seal.
- Apply sealing compound to the guide surfaces of the integrated seal groove in the bottom half of the housing.

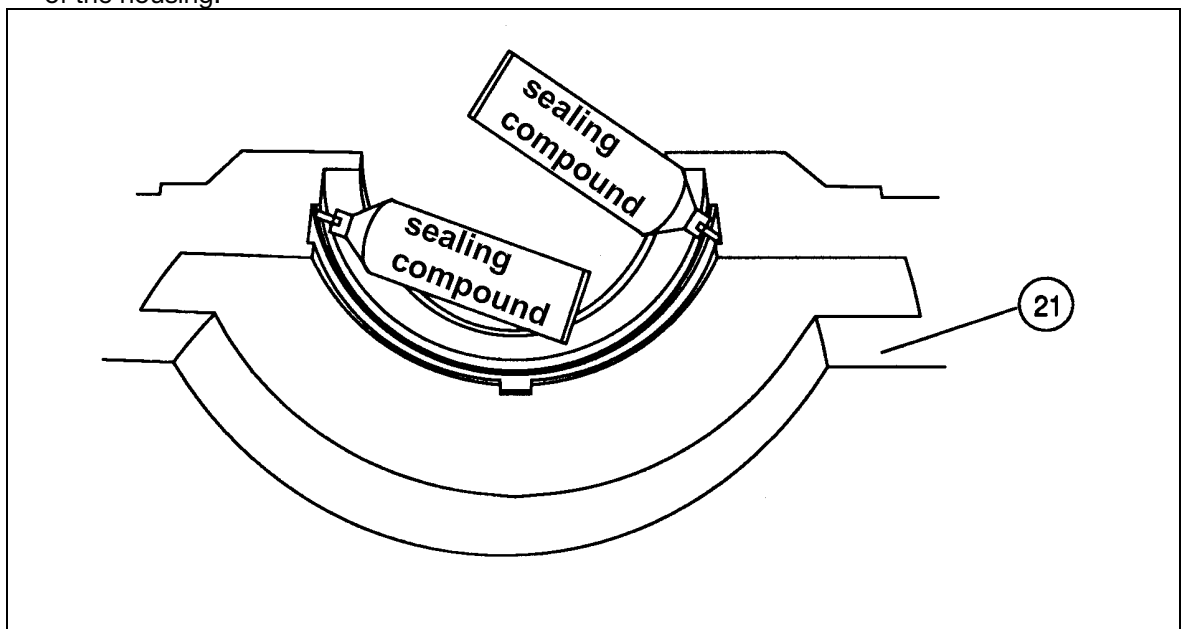


Illustration 4: Application of sealing compound to the integrated seal groove

- Apply a uniform layer of sealing compound to the seal surfaces and on the split line surfaces of both halves of the seal (41), (42).

Please observe the instructions for the use of sealing compound.

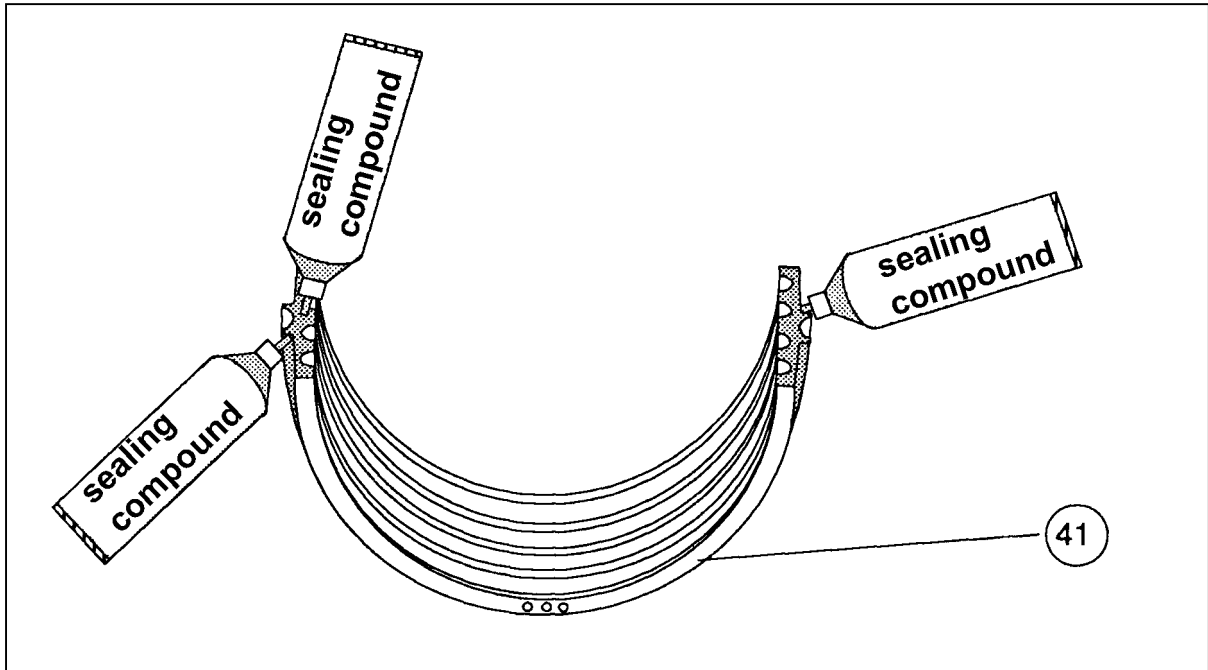


Illustration 5: Application of sealing compound to the floating labyrinth seal

- Place the bottom half of the seal (41) with the labyrinths onto the shaft.
- The oil return holes at the bearing side must be clear and open.
- Turn the seal in opposite direction from the anti-rotation pin into the groove of the housing until the split lines of the bottom half of the housing and the bottom half of the seal match each other.
- Remove the residue of sealing compound.
- Push the garter spring into the integrated seal groove between the bottom half of the housing and the seal until both ends jut out from the split line.
- Place the top half of the seal with the cam facing the inside of the bearing on the bottom half of the seal.
- Stretch the garter spring till both ends can be hooked.

8.3 Installation of the loose oil ring

- Open both split lines of the loose oil ring (33) by untightening and removing the screws (36). Separate both halves of the loose oil ring (33) carefully without using any tools or other devices.

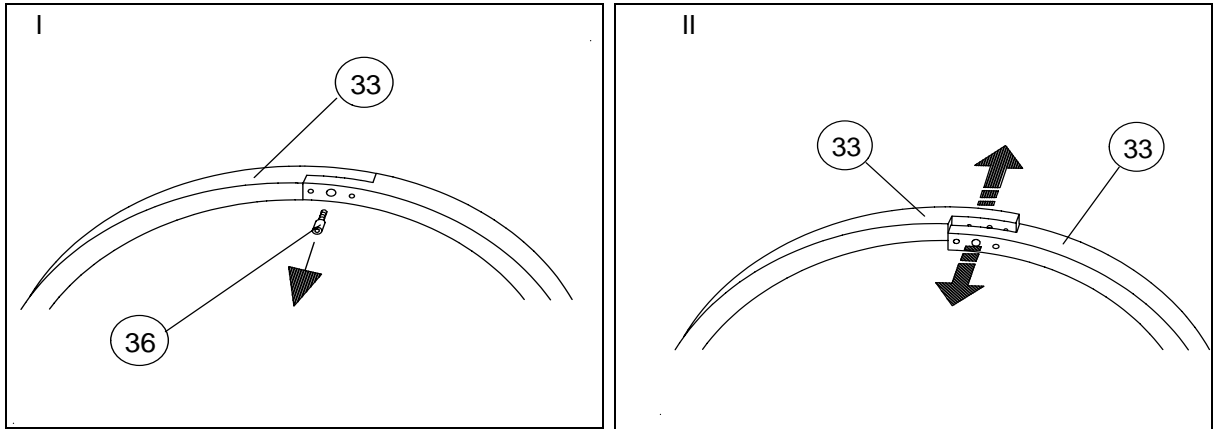


Illustration:6 Opening of the loose oil ring

- Place both halves of the loose oil ring into the shell groove (18) encircling the shaft. Press the positioning pin (34) of each split line into the corresponding hole (35).
- Adjust both halves of the loose oil ring till the split lines match each other.

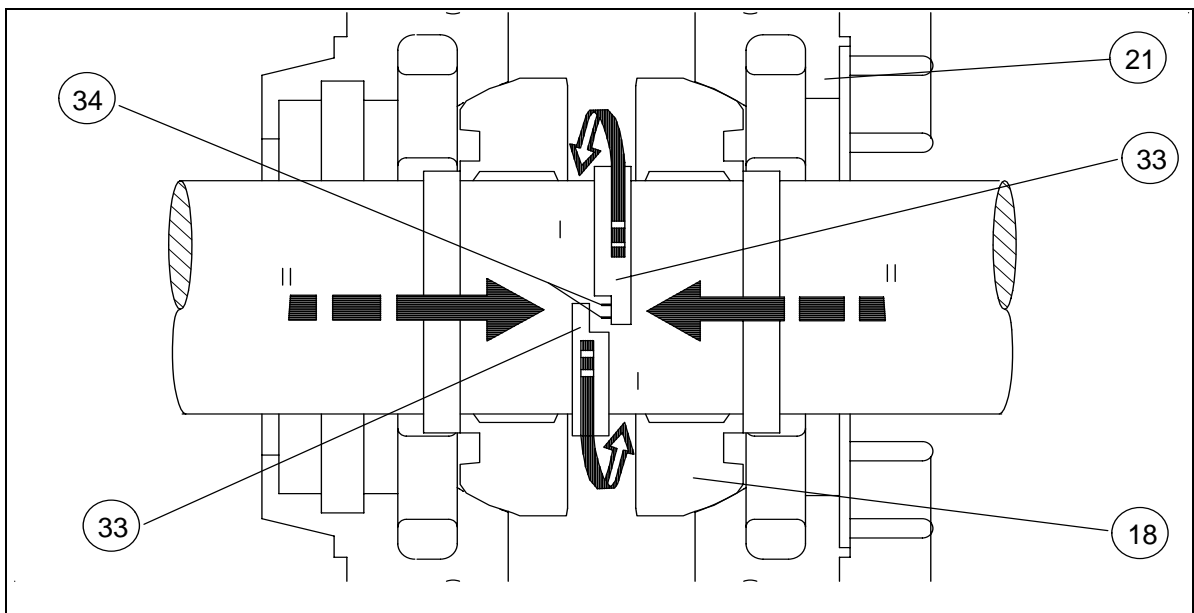


Illustration 7: Installation of the loose oil ring

- Tighten the screws (36) to the following torque rates:

| | | | | | | |
|--------------|-----|-----|-----|-----|-----|-----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 1,4 | 1,4 | 1,4 | 2,7 | 2,7 | 2,7 |

8.4 Fitting in the top half of the shell

- Apply some lubricant to the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).
- Check if the engraved numbers (20) on the bottom and top halves of the shell correspond.
- Place the top half of the shell (11) on the shaft; both engraved numbers (20) should be on the same side.

Attention!

An incorrectly placed shell could jam the shaft thus leading to the damage of both shaft and bearing.

**EM..B,
EM..K,
EM..E**

Attention!

Place the top half of the shell carefully on the shaft. The thrust parts of the top half of the shell must not be damaged.

insulated bearings

In the case of bearings arranged for insulation monitoring, connect the black cable for insulation monitoring to the shell.

According to the bearing type, there are two possibilities of connection.

1. The black cable is provided with a cable connector.

- Plug the cable with the cable connector into the counterpart available on the top of the shell.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

2. The black cable is provided with an eyelet.

- Fasten the cable with the eyelet to the split line of the shell, by using one of the shell joint bolts.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

- Tighten up the screws (24) of the shell to the following torque rates:

| | | | | | | |
|--------------|---|----|----|----|----|-----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 8 | 8 | 20 | 69 | 69 | 170 |

- Check the split line of the shell by using a feeler gauge. The split line gap should be less than 0,05 mm. If the split line is greater than this, dismantle both top and bottom (11),(18) halves of the shell. Rework the split line surfaces of the top half (11) and bottom half (18) of the shell with an oil stone.
- Check the mobility of the loose oil ring (33).

**EM.L.
Marine
Bearing**

A guide bush in the top half of the shell secures the function of the loose oil ring.

- Check the mobility of the loose oil ring (33) in the guide bush.

EM..E

Shells with taper land faces suitable only for one direction of rotation are marked with an arrow on the top half shell, which indicates the sense of rotation of the shaft.

The arrow indicates the allowed direction of shaft rotation after completion of the bearing assembly.

- Before mounting the top half of the housing check that the proposed direction of rotation of the shaft corresponds to the direction indicated by the arrow on the top half of the shell.
- If the directions match, continue the assembly of the bearing.
- If the directions do not match, the shell must be disassembled, re-aligned and mounted again.

Attention!

A wrongly placed shell, without observance of the direction of rotation of the shaft, impairs the operational safety of the bearing.

8.5 Closing of the bearing

- Check the true alignment of the shell (11), (18) and bottom half (21) of the housing.

The positioning pin (8) in the top half of the housing fits in the corresponding hole (4). The shell is thus placed into its right position.

- Check if the engraved numbers (1) on the top and bottom halves of the housing correspond.
- Clean the split line surfaces of the top and bottom halves (2), (21) of the housing.
- Apply sealing compound over the whole surface of the split line of the bottom half (21) of the housing.

Please observe the instructions for the use of sealing compound.

- Place the top half of the housing carefully into the machine shield, without touching the seals or the shell.

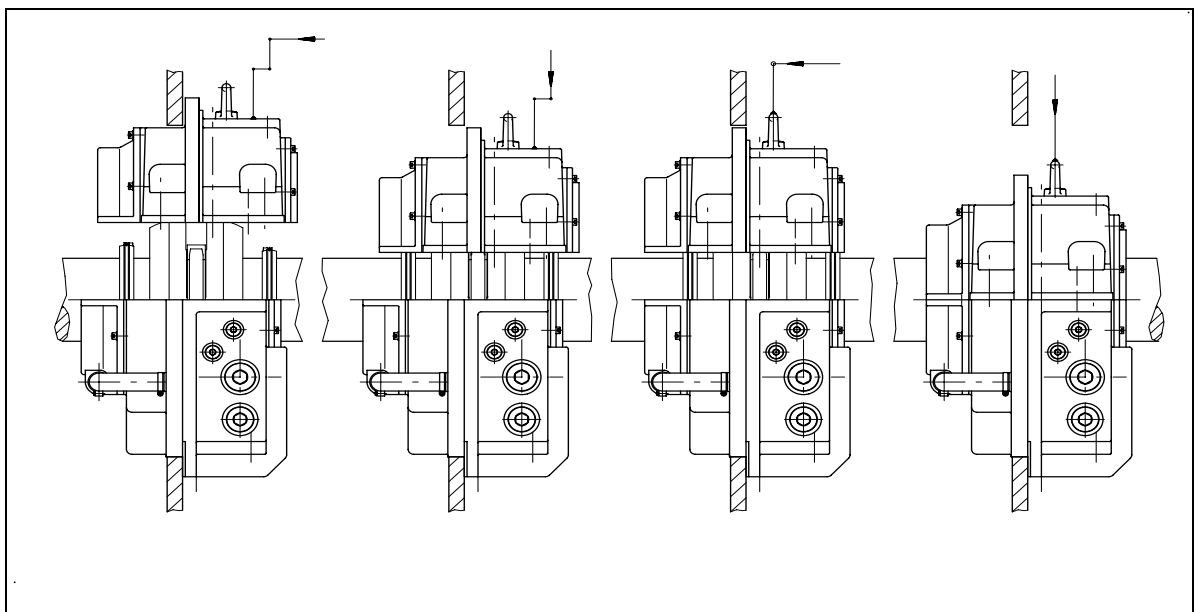


Illustration 8: Assembly of the top half of the housing

Maintenance and Inspection

- Lower the top half of the housing (2) vertically on the bottom half of the housing (21). Lower the top half of the housing (2) till the split line of the housing is not visible any more.
- Gently hit the bottom half of the housing (21) with a nylon hammer, thus ensuring the alignment of the spherical seating.
- Insert the screws (16) at the split line of the housing. Tighten them crosswise to the following torque rates:

| | | | | | | |
|---|----|----|-----|-----|-----|------|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] $\mu_{\text{tot}} = 0,1$ (lightly oiled) | 40 | 69 | 170 | 330 | 570 | 1150 |

Size 22 and 28.

- Unscrew the assembly device and put it back into its "parking position" behind the flange. Tighten the assembly device by using the following torque: 40 Nm.
- Replace the top sight glass and screw it hand-tight.

insulated bearings

Insulation monitoring

In the case of electric insulated bearings provided with insulation monitoring, the cable coming out of the housing must be connected in a professional manner.

According to the type supplied, please follow the assembly instructions given below.

- The cable is very short and provided with a further cable connector at the end of it. This cable is ready for connection to the housing. The bottom half of the housing is provided with the counterpart.
- Plug the cable connector into the counterpart.

Attention!

This connection bypasses the electrical insulation of the bearing. In the case of electric machines, make sure at least one bearing is electrically insulated.

To check the electrical insulation, interrupt the connection cable - housing. Check the electrical resistance with a suitable measuring instrument. Make sure that both bearings and the coupling are electrically insulated.

- The cable has a free end. In this case the customer has to make the connection.

Attention!

If only one bearing is insulated, the end of the cable must not be earthed.

Any further connection depends on the customer's requirements related to the insulation monitoring and can not therefore be described here.

8.6 Assembly of the Seals - Outboard Side

- Assemble the outboard side seals.

Proceed according to the seal type used:

- Floating labyrinth seal (Type 10) Chapter 8.6.1
- Floating labyrinth seal with dust flinger (Type 11) Chapter 8.6.2
- Floating labyrinth seal with baffle (Type 12) Chapter 8.6.3
- Rigid labyrinth seal (Type 20) Chapter 8.6.4
- Rigid labyrinth seal with dust flinger (Type 21) Chapter 8.6.5
- Rigid labyrinth seal with baffle (Type 22) Chapter 8.6.6

Type 10

8.6.1 Floating labyrinth seal (Type 10)



Warning of injury!

During assembly hold the garter spring ends (38) securely to avoid them suddenly releasing and causing possible injury!

Check the movement of the floating labyrinth seal on the shaft:

- Put the garter spring (38) around the shaft and hook both ends into each other.
- Put both halves of the seal (41), (42) in their place on the shaft.
- Put the garter spring (38) into the groove (39).
- Turn the floating labyrinth seal on the shaft.

Attention!

The floating labyrinth seal should turn easily on the shaft. A jammed seal could lead to overheating during operation and even to shaft wear.

If the floating labyrinth seal jams,

- dismantle the seal and
- remove the worn parts of the seal carefully, by using emery paper or a plain scraper.

- Dismantle the floating labyrinth seal.

Maintenance and Inspection

- Apply a uniform layer of sealing compound to the seal surfaces and on the split line surfaces of both halves of the seal (41), (42).

Please observe the instructions for the use of sealing compound.

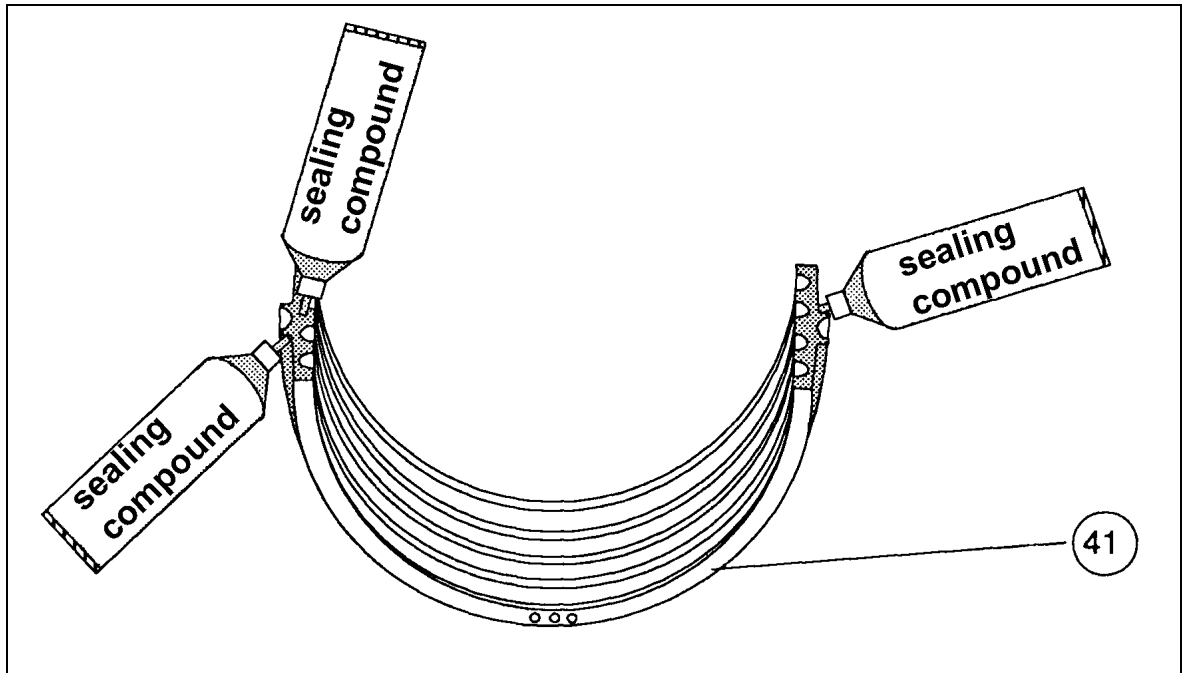


Illustration 9: Application of sealing compound to the floating labyrinth seal

- Press the bottom half of the seal (41) against the shaft.
- Place the top half of the seal (42) on the shaft and align both halves of the seal to each other.
- Place the garter spring (38) into the groove (39) and stretch until both ends can be hooked.

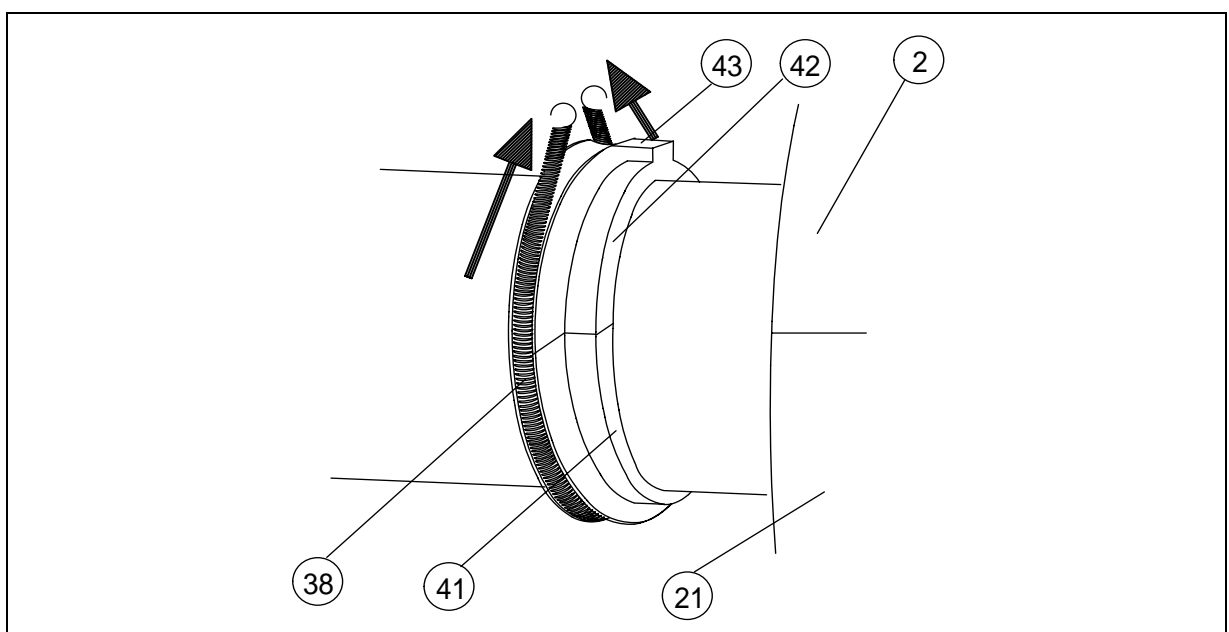


Illustration 10: Assembly of the floating labyrinth seal

- Place in true alignment the split line of the floating labyrinth seal and the split line of the seal carrier.
- Check that both engraved numbers (45) and (47) on top and bottom halves of the seal carrier (37), (40) correspond.
- Clean the following parts:
 - the seal surfaces of the top (37) and bottom (40) half of the seal carrier (the groove of the floating labyrinth seal, the flange surfaces)
 - the split line surfaces of the top (37) and bottom (40) half of the seal carrier
 - the flange surfaces of the housing.
- Apply a uniform layer of sealing compound to:
 - the lateral surfaces of the groove at the top (37) and bottom (40) half of the seal carrier
 - the flange surfaces of the top (37) and bottom (40) half of the seal carrier
 - the split line surfaces of the bottom half of the seal carrier (40).

Please observe the instructions for the use of sealing compound.

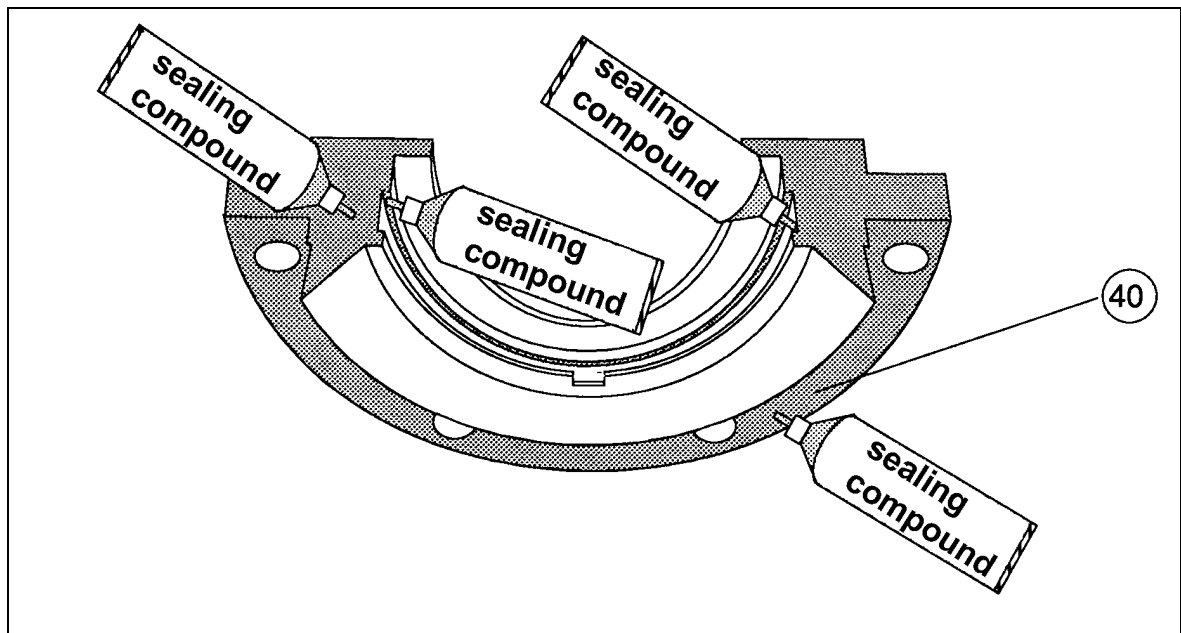


Illustration 11: Application of sealing compound to the seal carrier

Maintenance and Inspection

- Place the top half of the seal carrier (37) on the top half of the seal (42). Press the bottom half (40) of the seal carrier against it. Push the shaft seal completely into the housing.

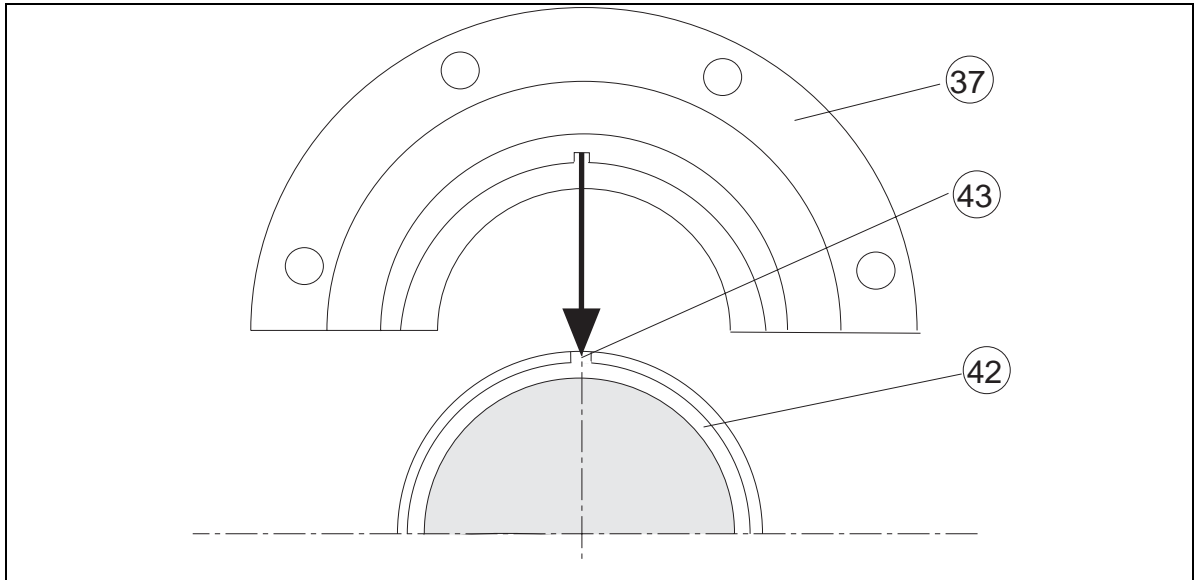


Illustration 12: Assembly of the seal carrier

- Place in true alignment the split lines of the seal carrier and the housing.
- Tighten up the screws (44) to the following torque rates:

| | | | | | | |
|--------------|---|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 8 | 8 | 8 | 20 | 20 | 20 |

Type 11

8.6.2 Floating labyrinth seal with dust flinger (Type 11)

- Assemble the floating labyrinth seal with dust flinger as described in Chapter 8.6.1, Floating labyrinth seal type 10.
- Place both halves of the dust flinger (58) in front of the shaft seal around the shaft. Loosely screw in the screws (59) at the split line of the flange.

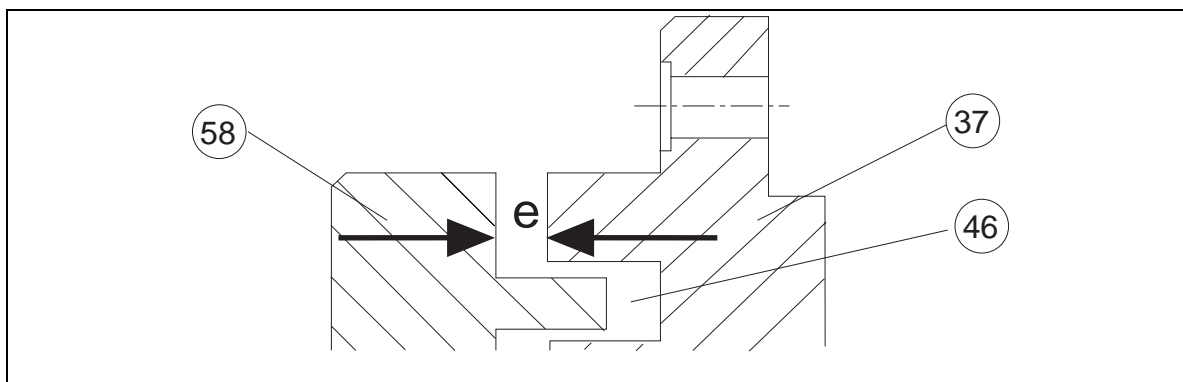


Illustration 13: Clearance between dust flinger and seal carrier

EM..Q

- Push the dust flinger (58) into the groove (46) of the seal carrier.
- Set the clearance "e" at the following figure around the whole unit:

maximum longitudinal extension of the shaft in operation + 1 mm

(Parameters indicated in the Technical Documentation of the Installation).

- Tighten up the screws (59) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 7 | 18 |

**EM..B,
EM..K,
EM..E,
EM..A**

- Push the dust flinger (58) into the groove (46) of the seal carrier.
- Set the clearance "e" at **1 mm** around the whole unit.
- Tighten the screws (59) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 7 | 18 |

Type 12

8.6.3 Floating labyrinth seal with baffle (Type 12)

- Assemble the floating labyrinth seal with baffle as in Chapter 8.6.1, Type 10.
- Apply a uniform layer of sealing compound to the flange surfaces of the top half (55) and bottom half (57) of the baffle.
- Screw
 - the top half of the baffle (55) onto the top half of the seal carrier (37)
 - the bottom half of the baffle (57) onto the bottom half of the seal carrier (40).
- Tighten the screws (56) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 4 | 10 |

Type 20

8.6.4 Rigid labyrinth seal (Type 20)

- Check if the engraved numbers (53) and (54) on the bottom half (52) and top half (48) of the rigid labyrinth seal correspond.
- Clean
 - the flange surfaces of the top half (48) and bottom half (52) of the rigid labyrinth seal
 - the split line surfaces of the top half (48) and bottom half (52) of the rigid labyrinth seal
 - the flange surfaces of the housing.
- Apply a uniform layer of sealing compound to the following parts:
 - the flange surfaces of the top half (48) and bottom half (52) of the rigid labyrinth seal
 - the split lines of the bottom half (52) of the rigid labyrinth seal.

Please observe the instructions for the use of sealing compound.

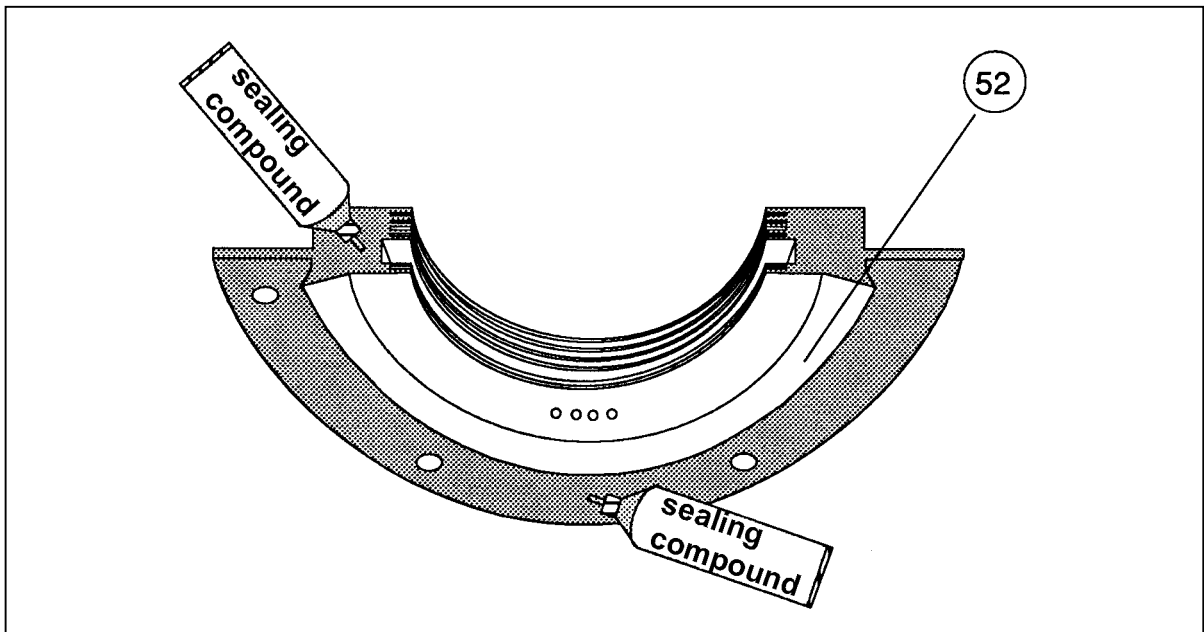


Illustration 14: Application of sealing compound to the rigid labyrinth seal

- Place the top half (48) of the rigid labyrinth seal on the shaft and press slightly the bottom half (52) of the rigid labyrinth seal from below against it. Lightly push the rigid labyrinth seal completely into the housing.
- Tighten the screws (50) to the split line of the labyrinth seal.
- Place in parallel alignment the split line of the rigid labyrinth seal and the split line of the housing. Press the rigid labyrinth seal slightly from below against the shaft. Adjust the rigid labyrinth seal in such a way that the clearance "f" between the shaft and the rigid labyrinth seal at both split lines has the same figure.

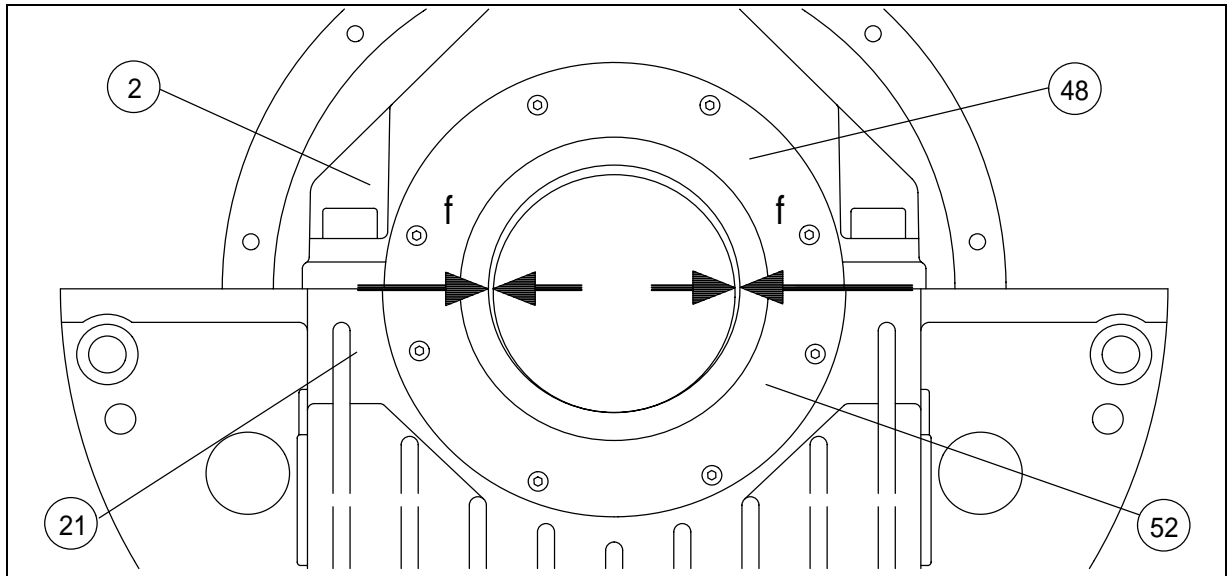


Illustration 15: Alignment of the rigid labyrinth seal

- Tighten the screws (49) to the following torque rates:

| | | | | | | |
|--------------|---|----|----|----|----|----|
| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
| Torque [Nm] | 8 | 8 | 8 | 20 | 20 | 20 |

**Type
21**

8.6.5 Rigid labyrinth seal with dust flinger (Type 21)

- Assemble the rigid labyrinth seal with dust flinger as indicated in Chapter 8.6.4, Type 20.
- Place both halves of the dust flinger (58) round the shaft, in front of the rigid labyrinth seal. Mount the screws (59) loose.

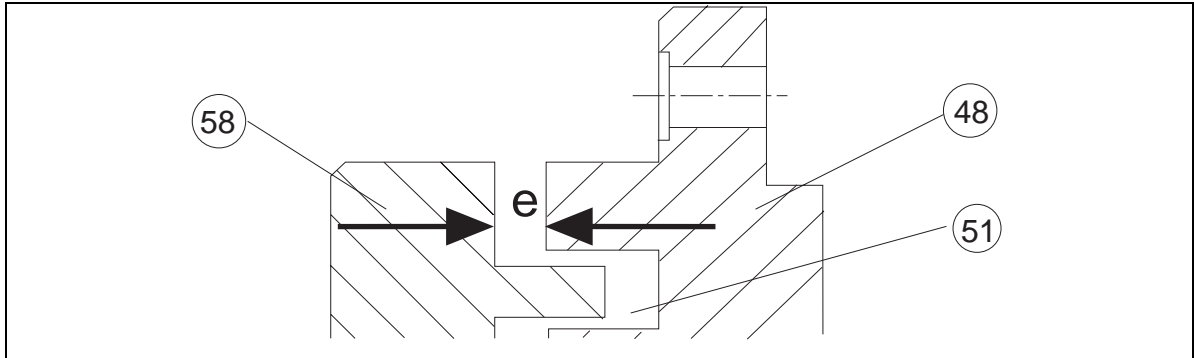


Illustration 16: Clearance between dust flinger and rigid labyrinth seal

EM..Q

- Push the dust flinger (58) into the groove (51) of the rigid labyrinth seal.
- Set the clearance "e" at the following figure around the whole unit:

maximum longitudinal extension of the shaft in operation + 1 mm

(Parameters are indicated in the Technical Documentation of the Installation).

- Tighten the screws (59) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 7 | 18 |

**EM..B,
EM..K
EM..E**

- Push the dust flinger (58) into the groove (51) of the rigid labyrinth seal.
- Set the clearance "e" at **1 mm** around the whole unit.
- Tighten the screws (59) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 7 | 18 |

**Type
22**

8.6.6 Rigid labyrinth seal with baffle (Type 22)

- Assemble the rigid labyrinth seal with baffle as described in Chapter 8.6.4.
- Apply a uniform layer of sealing compound to the flange surfaces of the top half (55) and bottom half (57) of the baffle.
- Screw
 - the top half of the baffle (55) to the top half (48) of the rigid labyrinth seal
 - the bottom half of the baffle (57) to the bottom half (52) of the rigid labyrinth seal.
- Tighten the screws (56) to the following torque rates:

| | | |
|--------------------|--------|------|
| Seal diameter [mm] | 80-140 | >140 |
| Torque [Nm] | 4 | 10 |

9 Starting Operation after Inspection

- Fit the thermo sensors for:
 - temperature measurement of the journal part in the connection holes (27)
- Retighten all screw plugs in the tapped holes (27), (28), (32) to the following torque rates:

| Screw plug threads | G 3/8 | G 1/2 | G 3/4 | G 1 | G 1 1/4 | G 1 1/2 | G 2 | G 2 1/2 |
|--|-------|-------|-------|-----|---------|---------|-----|---------|
| Torque [Nm] for plugs with moulded on plastic seal | 30 | 40 | 60 | 110 | 160 | 230 | 320 | 500 |
| Torque [Nm] for plugs with elastic seal | 34 | 60 | 85 | 130 | 240 | 300 | 330 | 410 |

- Check if the top sight glass (9) is tight.
- Check if the oil sight glass (19) is tight, the screws should be hand-tight.
- Carry out a visual check of the assembled bearing.
- Remove the screw plugs from the oil filling hole (3).

Attention!
Make sure that no impurities get into the bearing.

- Using a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filling hole (3) up to the middle point of the oil sight glass (28).
The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass

maximum oil level: top of the oil sight glass

Attention!

- Not enough lubricant leads to temperature rises and thus to damage to the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant have a breaking effect on the oil rings, thus leading to damages to the bearing.

- Tighten the screw plug into the oil filling hole (3) to the correct torque rates:

| Bearing size | 9 | 11 | 14 | 18 | 22 | 28 |
|--------------|----|----|----|----|----|----|
| Torque [Nm] | 30 | 30 | 30 | 40 | 60 | 60 |

- Check that the temperature monitoring equipment works.
- Start operating the cooling water supply system and check its functioning.

EMW..

The bearing is ready for operation.

- Close the assembly opening of the machine shield (with the thin metal plate (5)).
- Supervise the bearing during the trial run (5 - 10 operating hours).
Pay special attention to:
 - oil level
 - bearing temperature
 - sliding noises of the shaft seals
 - tightness
 - occurrence of inadmissible vibrations.

Attention!

If the bearing temperature exceeds the calculated value by 15 K (see the EDP-bearing calculations) stop the installation immediately. Carry out an inspection of the bearing and find out the causes.

10 Corrosion Protection for Longer Standstill Periods

If you want to protect the bearing mounted on an installation against corrosion proceed as follows:

- Dismantle the bearing (see Chapter 6).
- Clean the bearing (see Chapter 7).
- Paint or spray the top half of the shell (11), the bottom half of the shell (18) and the shaft with TECTYL 511.
- Assemble the bearing (see Chapter 8).
- Close all connection holes with screw plugs.
- Seal the gaps between
 - shaft seal and housing
 - shaft seal and shaftby using a self-adhesive, permanent tape.
- Remove the top sight glass (9). Spray some anti-corrosive such as TECTYL 511 or VALVOLINE into the bearing.
- Put a bag of dessicant (silicate gel) inside. The dessicant absorbs the humidity and prevents the formation of condensation water into the bearing.
- Close the bearing tight with the top sight glass (9).

In case the standstill period is **longer than 1/2 year**:

- Repeat the preservation procedures.
- Put a new bag of dessicant into the bearing.

In case the standstill period **lasts more years**:

- Dismantle the shells.
- Preserve and store the bearing parts.

11 Transport Protection

In case of a machine equipped with slide bearings type EM:

- Carry out the corrosion protection as described in Chapter 10 and apply enough lubricant on the working surfaces of the bearing.
- Secure the shaft against thrust and radial movements during transport.

12 **Glossary**

- Baffle** With bearing types 10 and 20 the baffles are assembled externally in front of the shaft seals. The baffle, made of reinforced polyamide, protects the bearing from dust and water.
- Rigid labyrinth seal** The rigid labyrinth seal (type 20) is used with slide bearings type E with high oil throughput. It corresponds to the protective system IP44 and is made of an aluminium alloy.
The rigid labyrinth seal is built of two halves, flanged at the housing. The labyrinths that wipe out the lubricant are arranged into two groups. The first two labyrinths, installed inside keep back most of the lubricant. Five further labyrinths protect the bearing from outside. They prevent the lubricant overflow and the ingress of impurities. The overflow lubricant is collected into a chamber between the both groups of labyrinths. Through the return bores the lubricant flows back into the bearing.
- Spherical seating** The spherical seating is a special feature enabling the alignment of the shell in the housing. The shell is seated on two spherical seatings. The advantages of the spherical seating are:
- easy at assembly
 - good heat transfer from the shell to the housing
 - suitable for such applications with high thrust or journal loads.
- Dust flinger** In the case of bearing types 10 and 20 a light alloy ring is clamped on the shaft in front of the shaft. This ring fits into a groove in the seal carrier or the rigid labyrinth seal, thus building a labyrinth. The labyrinth protects the shaft exit against low pressure that could otherwise absorb the lubricant. Low pressure occurs for instance in the case of rotating discs, such as couplings or cooling discs.
- Floating labyrinth seal** The floating labyrinth seal (type 10) in the seal carrier is used as a shaft seal in the case of bearings type E operating under normal conditions. It prevents the lubricant and lubricant mist coming out and the ingress of impurities. The floating seal has a high capacity of resistance to wear. It is made of a high-performance, high temperature stability and electrically insulated plastic material. The floating seal consists of two halves held together by a garter spring. Both ends of the spring are hooked together. In the case of slide bearings type EM the floating seal is mounted into a two-piece seal carrier. The groove allows for radial movement of up to 1 mm. The seal is thus insensitive to shaft radial displacement or deflection. The sealing effect is produced by the baffles wiping off the lubricant from the shaft. The lubricant flows back into the bearing via oil return opening.
- Machine seal** In the case of the flange mounted bearings, the machine seal reduces the influence of positive and negative pressure in the machine thus preventing leakages at the inner seal area. The space between the machine seal and the bearing housing must always be vented to atmospheric pressure. The size of the gap between shaft and machine seal influences the sealing effect.